

Appendix B

Gulfport Container Volume Projections

DRAFT
GULFPORT CONTAINER VOLUME PROJECTIONS

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I. INTRODUCTION

This document provides container volume projections to support the Environmental Impact Statement (EIS) for the Port of Gulfport (Gulfport).

The report begins with a brief review of container volumes from a historical perspective and current container cargo flows through Gulfport. Later sections of the report provide projections for Gulfport container volumes through the year 2060. Container volume scenarios include:

- **Baseline**, assuming no substantial changes in commodities handled, changes in liner container services, or other factors that could positively or negatively affect container volumes beyond increases that could be expected due to economic growth and consumption of products.
- **Low Growth**, assuming lower growth than that included in the baseline projection or loss of current market share.
- **High Growth**, assumes higher growth than the baseline projection.
- **Optimistic**, includes growth due to expansion into new markets.

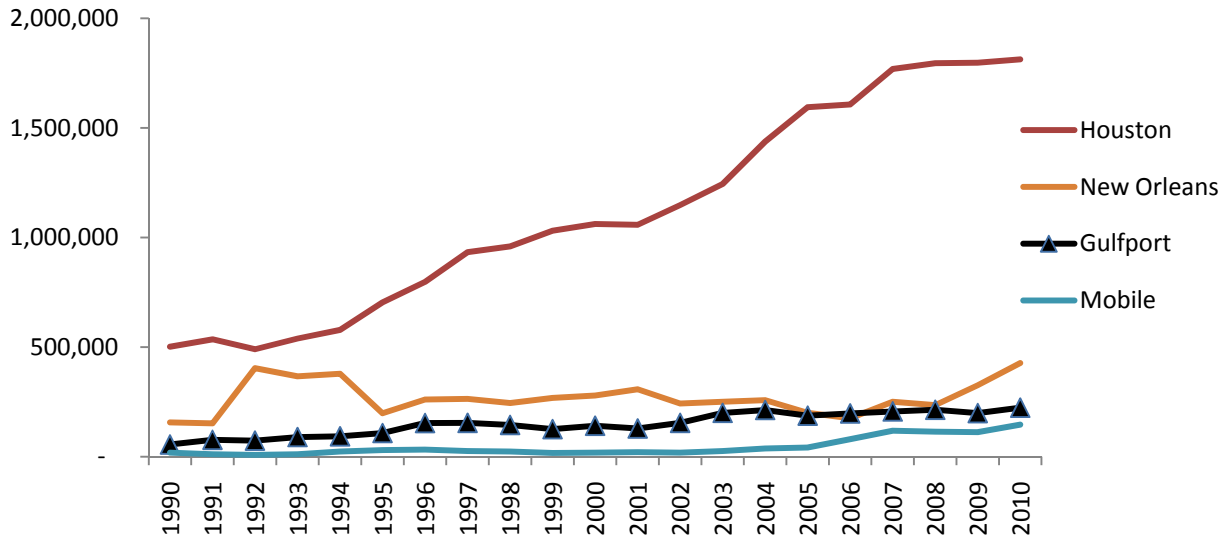
II. RECENT HISTORY AND CURRENT STATUS

Gulfport and other ports in the Gulf of Mexico (Gulf) have grown more modestly than the Port of Houston over the past two decades (Figure 1).

Gulfport's container volumes have grown over the past two decades first reaching the 200,000 twenty-foot equivalent unit (TEU) level in 2003 and then attaining a new peak of 223,740 TEUs in 2010. The Gulfport has generally maintained the 200,000 level of volume since 2003, representing about 0.5% of the U.S. total. Hurricane Katrina caused a significant disruption in volume and shares of the U.S. total, with declines in Gulfport as well as New Orleans in 2005 (Figure 2).

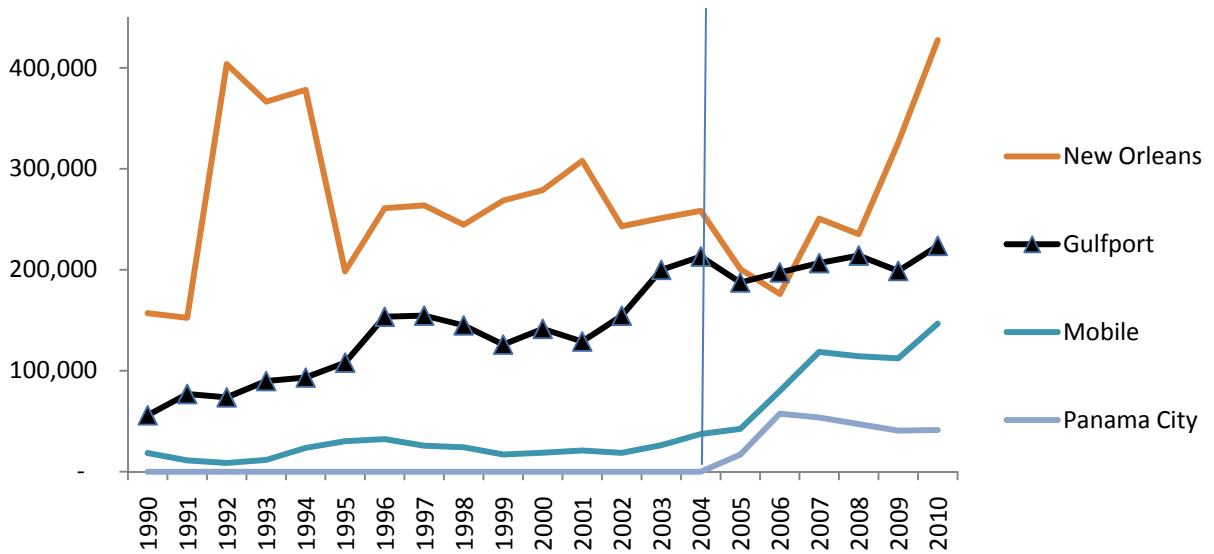
Importance of Imports

As is the case for many other U.S. ports, Gulfport's container trade is dominated by imports, with imports exceeding exports by a ratio of over 2 to 1 in terms of value (Figure 3) and also in terms of tons. This imbalance means that container trade is driven primarily by imports with empty containers generally comprising a large share of containers outbound from U.S. ports.



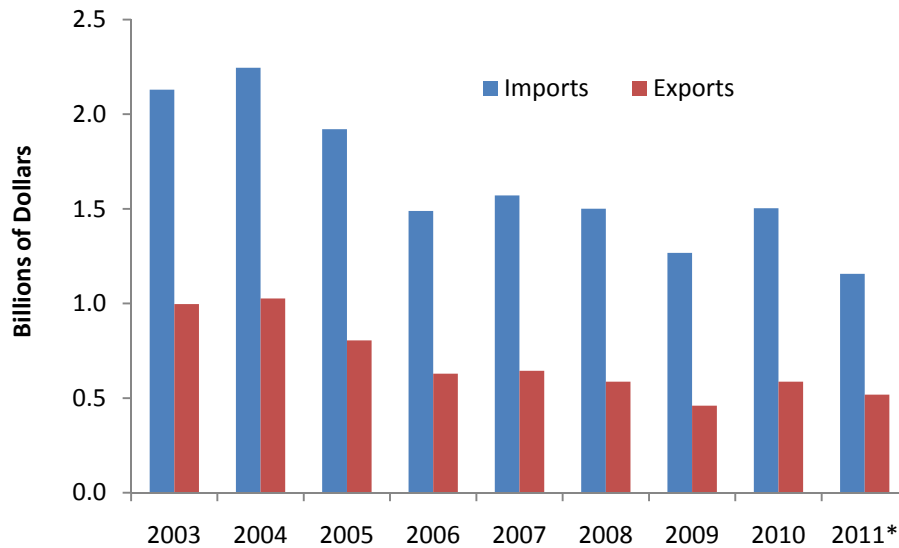
Source: American Association of Port Authorities (AAPA).

Figure 1. TEU Volumes for Largest Gulf Ports



Source: AAPA.

Figure 2. Container Volume History for Central Gulf Ports



Source: U.S. Census Bureau and PB analysis
 * 2011 data is year to date through September

Figure 3. Gulfport Container Imports Have Historically Exceeded Exports

Principal Gulfport Trade Regions and Containerized Commodities

Based on U.S. Census data for 2010, Gulfport shares of U.S. containerized import tons by major world region are as follows:

- **Total U.S. Imports** **0.7%**
- Americas (except Mexico) 2.7%
- Mexico 1.0%
- Northeast Asia 0.0%
- Europe 0.0%
- Southeast Asia/Oceania 0.8%
- South Asia 0.0%

From this data it can be seen that Gulfport's principal trade is with countries to the south of the United States rather than with other world regions. Major import commodities and the origin regions are:

- Bananas (Central America)
- Apparel (Central America)
- Titanium ores (ilmenite) (Australia/Africa)

Container liner services handling imports are currently provided by three carriers: Dole, Chiquita, and Crowley (Figure 4).

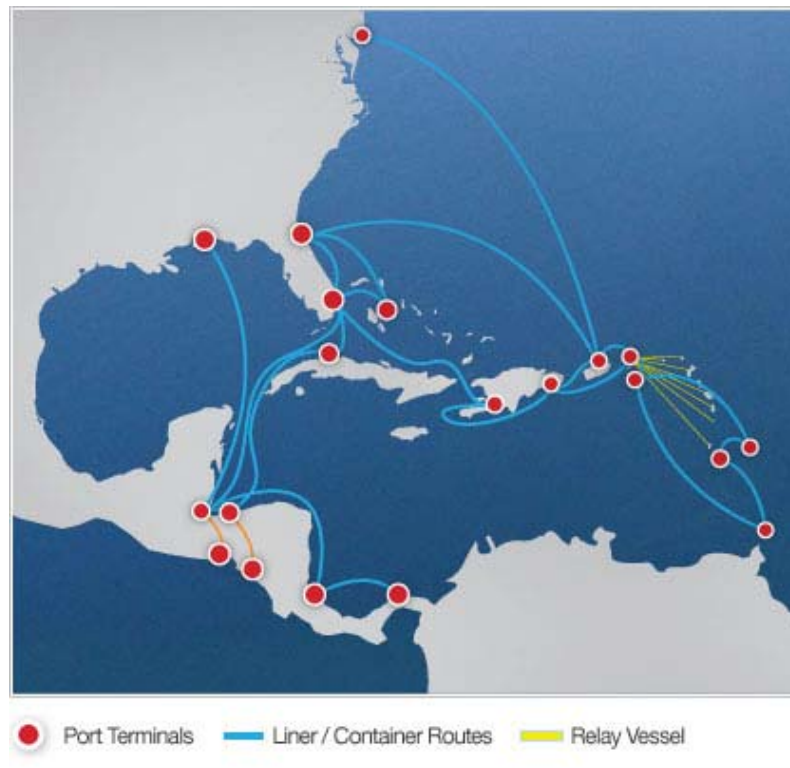


Figure 4. Crowley Marine Liner Services

III. BASELINE CONTAINER PROJECTION

A baseline container volume projection has been derived from the most recent Federal Highway Administration (FHWA) Freight Analysis Framework (FAF) database (released January 2011). This database includes forecasts through 2040 of dollar value and tons for 43 product groups defined by Standard Classification of Transported Goods (SCTG) commodity groups between 123 domestic geographic zones, by mode, for movement of domestic goods, imports, and exports (see Appendix for a further description). The State of Mississippi is one of the FAF zones both for domestic origins and destinations and also a U.S. gateway for imports and exports.

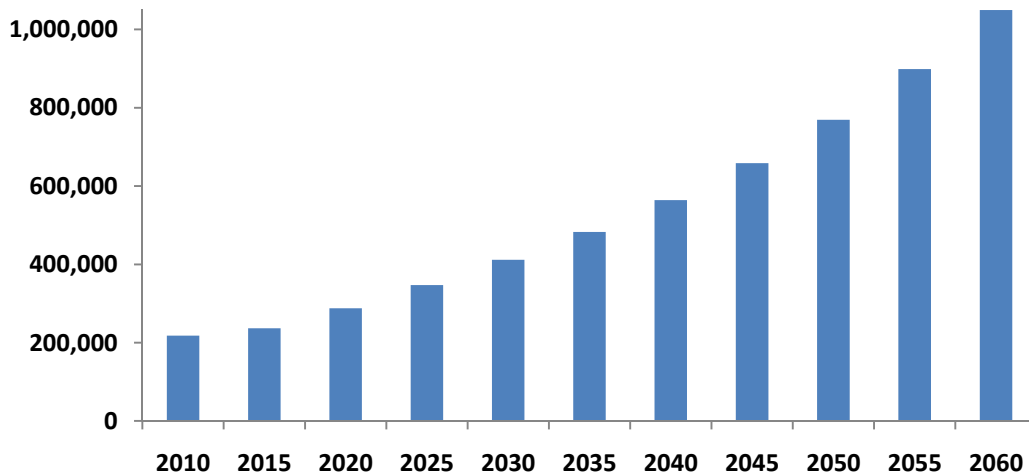
Forecasts of import tons through Mississippi have been used to project total container volumes for the Port of Gulfport, with Gulfport representing nearly all Mississippi container traffic. Since FAF data does not directly identify container volumes, 19 FAF commodity groups that are most heavily containerized (Table 1) have been used to project container volumes. Forecasted growth rates for total waterborne import tons for these 19 product groups were applied to 2010 Gulfport TEU volumes to produce the baseline projection. TEU volume will grow to a projected 564,000 in 2040 under this baseline scenario, an increase of over 150% from 2010 volumes of 224,000 TEUs (Figure

5). Volumes for 2040 through 2060 are extrapolated based on the projected 2035 to 2040 growth rate of 2.7%. Projected volumes are 1.05 million TEUs in 2060.

Table 1. Projections of U.S. Waterborne Imports Entering the U.S. through Mississippi
Thousands of Metric Tons
(2010 data is interpolated from 2007 and 2015 FAF forecast values)

SCTG	2007	2010	2015	2020	2025	2030	2035	2040
Container	1,052	1,110	1,206	1,465	1,768	2,097	2,459	2,872
01 Other ag. prods.	659	709	792	978	1,197	1,433	1,699	1,996
03 Meat/seafood	1	1	1	1	1	1	1	1
04 Milled grain prods.	26	27	29	35	41	48	56	66
05 Other foodstuffs	51	55	62	65	68	72	76	81
06 Tobacco prods.	0	0	0	0	0	0	0	0
13 Chemical prods.	0	1	1	1	1	1	1	2
14 Plastics/rubber	7	7	7	9	11	14	17	20
16 Wood prods.	98	90	75	83	91	100	109	120
17 Newsprint/paper	0	0	0	0	0	0	0	0
18 Paper articles	0	0	0	0	0	0	0	0
19 Printed prods.	0	0	0	0	0	0	0	0
20 Textiles/leather	144	153	170	198	230	265	306	356
23 Articles-base metal	4	4	5	6	7	8	10	12
24 Machinery	54	54	55	76	101	131	156	186
25 Electronics	6	7	8	11	14	18	21	25
26 Motorized vehicles	0	0	0	0	0	0	0	0
28 Precision instruments	0	0	0	1	1	1	1	1
29 Furniture	1	1	1	1	2	3	3	4
30 Misc. mfg. prods.	1	1	1	1	1	1	1	2

Source: FHWA FAF database and PB analysis



Source: PB analysis.

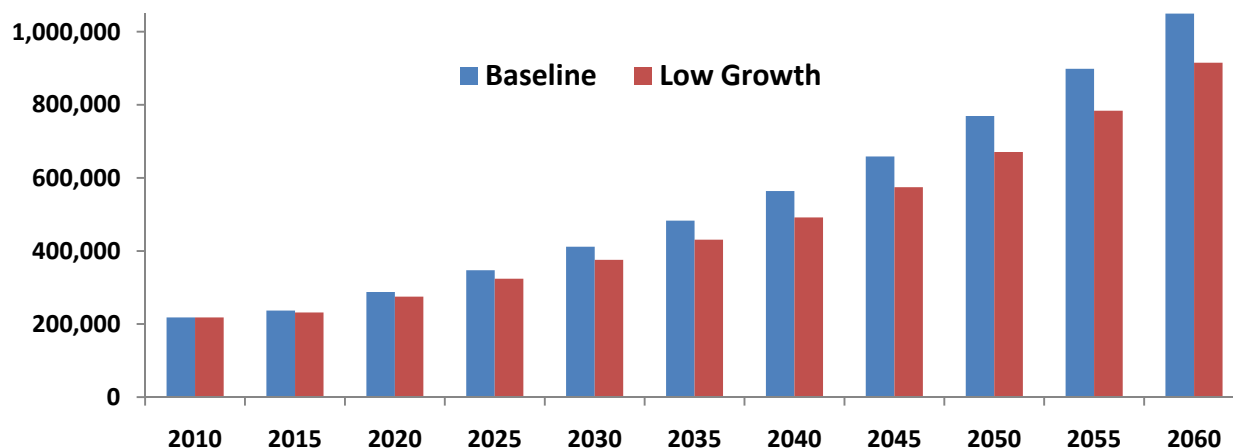
Figure 5. Baseline Projection of Gulfport Container Volumes in TEUs

The baseline volume forecast is essentially a status quo scenario with growth projected in current markets and commodity flows. The compound average annual growth rate for 2010 to 2040 aggregate volumes is 3.3%. It should be noted that the baseline scenario assumes the Port of Gulfport Restoration Project is completed.

Growth and tonnage of “other agricultural products” (which include fresh fruit and vegetables) comprises a large and growing portion of Gulfport’s baseline projection, with above-average growth also in machinery. “Textiles/leather” (which includes apparel) is a large volume category with slightly below-average growth projected.

IV. LOW GROWTH SCENARIO

A low growth scenario for Gulfport container volumes is derived from the baseline projection but includes lower long term growth, i.e., a reduction of 0.5% per year in average annual growth, or 2.8% rather than 3.3%. Such lower growth could result from lower consumption of goods, alternative sourcing of goods such as apparel, or successful competition from other ports. Under this scenario, container volumes would reach just under 500,000 TEUs in 2040 or 2.25 times 2010 volumes. Volumes would be 915,000 TEUs in 2060.



Source: PB analysis.

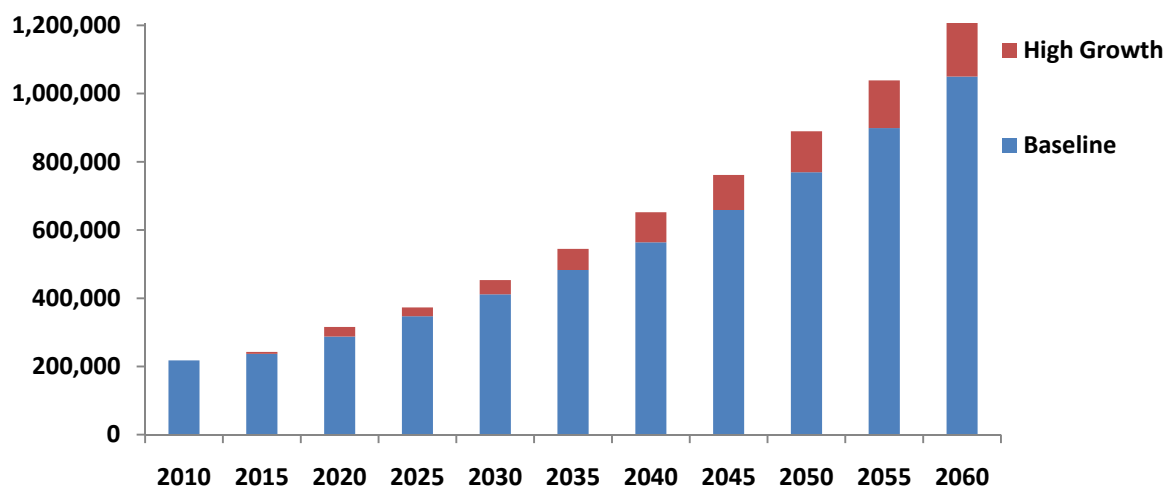
Figure 6. Low Growth Gulfport Container Volume Scenario in TEUs

V. HIGH GROWTH SCENARIO

A high growth scenario for Gulfport container volumes is also derived from the baseline projection but includes higher long term growth, an increase of 0.5% per year in average annual growth (e.g. 3.8% rather than 3.3% growth in the baseline projection for 2010 to 2040).

Higher growth could result from increased consumption of goods due to higher U.S. economic growth. Another possibility is that volumes of Central American imports could increase more than the projection included in the baseline scenario. This could occur as a result of shifts in sourcing (“near-shoring”) of apparel imports from Central America rather than from China, Southeast Asia, or other regions. Finally, growth in Gulfport import volumes from the Americas could result from increasing shares of current Central American markets, for example by attracting more banana, apparel, or other product imports. Such increases could be achieved by successfully competing with other ports based in part on Gulfport’s improved port facilities and supporting inland infrastructure.

Under this scenario, container volumes would reach 650,000 TEUs in 2040, or 3.0 times 2010 volumes, and reach 1.2 million TEUs in 2060.



Source: PB analysis.

Figure 7. High Growth Gulfport Container Volume Scenario in TEUs

VI. OPTIMISTIC GROWTH SCENARIO

Potential scenarios for additional growth based on expanded markets have been examined on a world region basis, where Gulfport might be able to increase container traffic particularly for U.S. imports which drive carrier services and calls.

Regions examined (and share of 2010 U.S. import container tons) include:

- Northeast Asia (Panama Canal expansion) 46%
- Europe 18%
- Americas, including Mexico 17%

Other world regions have small volumes of U.S. imports (a total of 19%)

Northeast Asia

Gulfport does not currently have Northeast Asia liner services and thus has a 0% share of total U.S. import tons. (Northeast Asia includes China, Hong Kong, Japan, South Korea, and Taiwan). U.S. container imports from Northeast Asian countries move principally through West Coast ports; 69% of containerized Northeast Asian import tons in 2010 were received on the West Coast, according to U.S. Census data. Based on FHWA FAF estimates, West Coast ports have dominant shares of U.S. inland markets as far east as Ohio, Memphis, and Dallas.

Over 26% of containerized import tons move through East Coast ports with the remaining 5% through Gulf ports. Gulf port traffic is generally focused on large markets along the Coast (especially the Houston region).

Panama Canal Expansion

Increased U.S. container import volumes from Northeast Asia through U.S. ports is a much anticipated effect of Panama Canal expansion expected to be completed by 2015. There are, however, five factors that are likely to limit these impacts for Gulf ports.

First, there is no reason to believe that aggregate container volumes will increase due to Panama Canal expansion. Lowered transportation costs that will result from use of larger ships will represent only a tiny fraction of overall product value, limiting any induced increases in consumption of imported goods to near zero. Thus import container volumes are a zero sum game with increased shares of cargo handled by some ports necessarily offset by decreases in others. Of course as aggregate U.S. volumes increase over time, ports that lose shares may still experience increased volumes but at a slower rate than ports gaining share. It is generally expected that some volumes will shift from West Coast ports to East and Gulf coast ports.

The second factor affecting potential shifts in container volumes is the potential size of cost reductions that may result from the use of larger ships (up to about 13,000 TEU capacity) that will be able to transit the expanded Panama Canal compared to the current 5,000 TEU “Panamax” maximum ship size able to transit the Panama Canal. It is expected that maximum transportation cost reductions may amount to several hundred dollars per TEU for goods moved to the U.S. East Coast where the largest new Panamax ships are likely to be deployed. However, cost reductions will likely be smaller for goods moving to the Gulf Coast that are likely to be carried by smaller ships given the shallower depths available in Gulf ports.

The third factor that may limit volume impacts is that transportation service providers are likely to retain a significant share of total cost reductions. In particular, liner companies will attempt to keep part of the savings to help pay for newer larger ships. In addition, through tolls and fees the Panama Canal Authority is likely to retain some of the cost savings to not only pay for canal expansion but also to maximize revenues and returns from Panama’s investments. To the extent that cost savings are retained, the cost reduction benefits to importers will be reduced, and this will dampen shifts that might occur due to such cost reductions.

Fourth, shifts in container volumes are likely to be limited to lower valued products where longer transit times required for Panama Canal transit are a less significant factor than marginal reductions in shipping costs. Shippers will continue to value quicker transit times for high value goods where inventory carrying costs and time to market are critical.

Finally, even for lower value products, U.S. regions where Gulf Coast ports provide lower total transportation costs are limited (Figure 8). Example destinations discussed below include Chicago, Memphis, and Atlanta.



Source: PB analysis.

Figure 8. Costs per TEU and Transit Times for Reaching Inland Regions from Northeast Asia (Shanghai)

Chicago

For shipments from Shanghai to Chicago through Seattle-Tacoma total ocean and rail costs are about \$1,000 per TEU (\$600 ocean and \$400 rail), and total transit time is about 14 days (excluding port and other dwell times). Note that costs are based on estimated costs for transportation services rather than rates which can fluctuate widely based on market conditions.

While rail distances from Gulf ports to Chicago are shorter, ocean distances are much greater given the Panama Canal route. As a result, ocean shipping costs using current Panamax ships would be much larger and outweigh the lower rail cost by about \$300 per TEU. Transit time would also be about 13 days longer. The cost difference would be greater if a larger 8,000 to 10,000 TEU ship were used for the Transpacific ocean transport to Seattle as opposed to the ships that likely will be used to serve Gulf ports. Thus, for goods moving from Northeast Asia to Chicago via the Panama Canal and a Gulf port rather than through the West Coast, the cost would be greater and the transit time longer, making such routing highly unlikely.

Memphis

The cost and transit time differentials are smaller for containers moving to Memphis than those destined for Chicago, but the results are similar. The total cost for ocean and rail transportation is about \$100 less per TEU for the West Coast route, and the difference in transit time is about 9 days longer making routing through Gulf ports unlikely.

Atlanta

For reaching Atlanta, ocean transportation costs to the Ports of Savannah (and/or Charleston) may be lowered due to Panama Canal expansion depending in part on whether these ports are dredged to depths to allow calls by larger container ships. If this occurs, costs could be lowered for moving goods to Atlanta through these ports, effectively strengthening Savannah's position in reaching the Atlanta market.

Miami's position as a possible competitor to South Atlantic ports will be enhanced given developments underway for deepening the Port of Miami and improving rail connections from Miami to Atlanta. If South Atlantic ports are not dredged to adequate depths and otherwise prepared to handle larger ships, Miami's competitive position would be strengthened further.

Gulfport and other Gulf ports will continue to be disadvantaged in reaching Atlanta due to higher inland transportation costs associated with longer highway and rail distances compared to connections through Savannah.

Conclusion for Northeast Asia

The analysis outlined above suggests that Gulfport's potential for increased Northeast Asian imports is likely limited to serving the Gulf Coast states of Texas, Louisiana, Mississippi, and Alabama. Given the relatively short distances involved, these markets would tend to be served through trucking, meaning that improved rail connections to Hattiesburg will have little positive impact.

A summary of Gulfport's potential for reaching these Gulf Coast markets is as follows:

- Texas is a very large market that will continue to be served primarily by Houston and other Texas Gulf Coast ports where goods are not imported through the West Coast. Houston will continue to be the principal Gulf port of call for most Northeast Asia liner services given its large local market and significant exports.
- Louisiana is a very small destination market compared to Houston. Small volumes are imported through New Orleans, with most volume moving through Southern California ports.
- Mississippi is also a very small market, largely served through Southern California ports.

- Alabama destinations are served to a small degree through Mobile in addition to Southern California and Georgia ports. Reaching Alabama destinations from Gulfport will always require longer trucking distances than from Mobile, minimizing this modest potential.

In summary, there is limited potential in local markets that could be served by Gulfport, and this potential would require development of local markets (e.g., distribution centers) and a willingness of carriers to add Gulfport as a call on Gulf services (like those currently calling Houston and Mobile) (Figure 9). This may be a chicken and egg situation, with market development requiring better access to shipping services, and new carrier services dependent on new market developments. The positive aspect of this is that Gulfport's revitalization could help make such developments possible.

Based on these conclusions, negligible growth in container volumes is expected for Northeast Asian trade for Gulfport, and increases in container volumes along this trade lane are not included in an optimistic scenario.



Figure 9. CMA CGM Pacific Express 3 Round-the-World Liner Service

Europe

Gulfport currently has no container liner services from Europe and therefore handles 0% of total U.S. containerized import tons. Imports from Europe are to a large degree an east-west mirror image of imports from Northeast Asia that move primarily through West Coast ports. About 70% of imports from Europe are transported through East Coast ports to U.S. inland destinations according to U.S. Census data. An examination of volumes for containerized commodity groups from FAF data (see Table 1) indicates that 56% of import tons from Europe are destined for states along the Atlantic seaboard with 84% of this volume moving through Atlantic Coast ports. Another 23% of European imports are destined for North Central states (from Arkansas and Tennessee north to the upper Midwest), and over 80% of this volume is imported through East Coast states.

A smaller 14% of U.S. import tons from Europe move through Gulf ports, although this represents a larger share than their 5% share of imports from Northeast Asia. Of the total Gulf port volume of European imports, nearly 80% moves through Texas ports. This occurs for two reasons:

- The Texas market is large and well-served by Texas ports (compared to East Coast ports).
- The Port of Houston acts as a gateway to California markets allowing relatively quick and less expensive transportation than Panama Canal services.

In theory, Panama Canal expansion could lower costs for transporting goods from Europe to the West Coast, decreasing the Gulf Coast share of such imports. However, since much larger ships are unlikely to be deployed on Europe-U.S. West Coast routes and, in any case, cost differentials would tend to be small, little impact on volumes is expected. If volumes were to decrease, this impact would be focused on Texas ports.

Given the dominance of U.S. East Coast ports in handling imported containerized goods from Europe destined for the large markets in Atlantic seaboard and North Central states, and the lack of cost reduction incentives that could change these patterns, potential for increased container volumes from Europe through Gulfport or Gulf ports in general is also expected to be negligible.

Americas

Imports from the Americas including Mexico, the Caribbean, Central America, and South America accounted for about 17% of total U.S. waterborne import tons in 2010 according to U.S. Census data, nearly the same as imports from Europe.

Compared to East-West trade lanes outlined above (Northeast Asia and Europe), Gulfport is likely to be far more competitive for North-South Americas container trade due to the Gulf's relative geographic proximity to these markets. Inland regions for which transportation services could be most competitive include the Central Gulf states of Louisiana, Mississippi, and Alabama but extend north in the Mississippi Valley to Illinois, Indiana, and neighboring states, essentially the southern shaded area shown in Canadian National's key markets map shown on Figure 10.

U.S. containerized imports from the Americas (excluding Canada) represent a large share Gulf Coast ports' container cargo, 41.3% of the total tons moving through ports in the Gulf Coast (including Texas, Louisiana, Mississippi, and Alabama).

Import tons originating in Caribbean, Central American, and South American countries represent a large portion of this trade, 15.4% of total U.S. containerized imports in 2010 and 38% of the cargo moving through Gulf Coast ports.

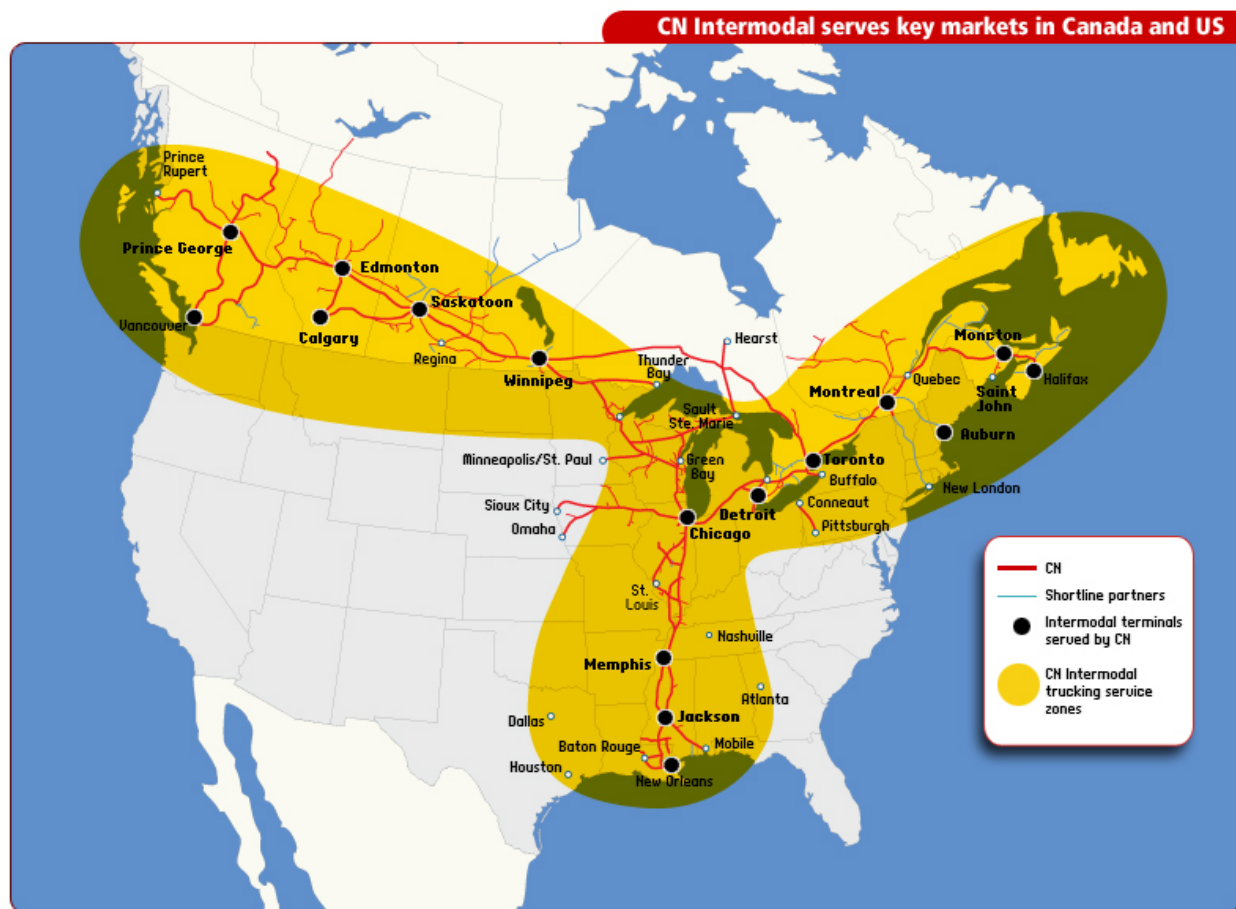


Figure 10. Canadian National Intermodal Services

While Mexico is one of the United States' largest trading partners, containerized imports from Mexico represent a much smaller 1.2% share of U.S. totals since most imports from Mexico are transported by truck or rail. Gulf state ports also handled 38% of waterborne imports from Mexico, with this cargo representing 3% of Gulf port totals.

Given the relative importance of import volumes compared to exports, imports from the Americas represents the principal driver of roughly 1 million TEUs per year moving through Gulf ports. Based on FHWA FAF forecasts this total will grow to 1.4 million TEUs in 2020 and 2.0 million TEUs in 2030.

Inland Markets Where Gulfport Can Be Most Competitive

For Gulfport to be competitive it must be part of an effective transportation network linking countries and products with U.S. inland markets. Components of this network include inland transportation (trucking and rail) and ocean liner services connecting country sources with

Gulfport and inland transportation services. Sections that follow examine inland transportation followed by a view of liner services.

Local Trucking Markets

Within current local trucking markets (primarily the Central Gulf Coast states of Texas, Louisiana, Mississippi, and Alabama) Gulfport is likely to be most competitive in areas directly to the north:

- In Texas, Houston and other Texas ports are likely to be most competitive due to shorter highway distances. Houston's dominance as a port of call is also a factor.
- In Alabama and areas to the east, Mobile has an advantage in highway distances and costs.
- Regions to the north, including areas in Mississippi and Louisiana and Memphis (which is 370 miles from Gulfport), may be competitive from Gulfport depending on local trucking market dynamics. However, given the small size of these local regional markets and competition from New Orleans and Mobile, overall growth potential is likely to be limited.

Longer Distance Rail and Long-Haul Truck Markets (>400 miles)

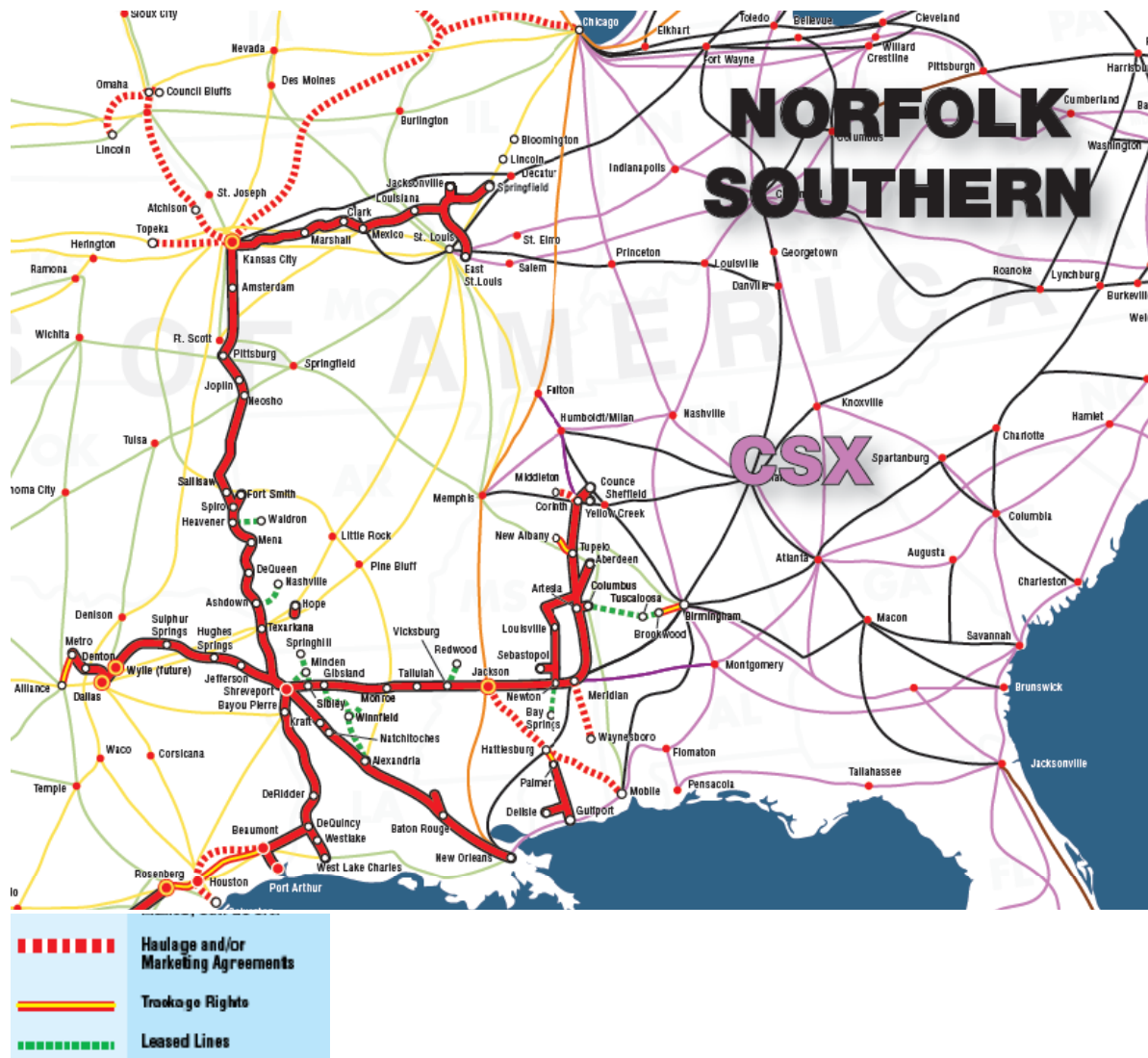
Gulfport's improved rail connection to Hattiesburg on Kansas City Southern (KCS) as shown on Figure 11 offers an opportunity to reach U.S. Midwest markets through Gulfport that has previously been impractical due to limitations of the current rail line. This means that Gulfport could be competitive with other Gulf ports and possibly with Atlantic Coast ports for serving these inland regions. Specific advantages by railroad could be:

For Kansas City Southern:

- Gulfport could provide an alternative from New Orleans north to Tennessee, which currently requires much longer routing through Shreveport. This route would involve use of haulage rights on CN's rail line between Hattiesburg and Jackson.
- Likewise, Gulfport could be an alternative from New Orleans, West Lake Charles, and Texas to regions west and north including Shreveport, Dallas, Kansas City, and St Louis.
- Either alternative requires haulage on Canadian National that may limit KCS interest.

For Norfolk Southern (NS), KCS connection in Hattiesburg provides:

- Alternative to the NS route out of New Orleans to Birmingham and regions to the north.
- Alternative to the NS route from Mobile to Birmingham and north.
- Use of either of these alternatives would require use of the KCS connection from Gulfport to Hattiesburg rather than direct service on NS-only routes.



Source: Kansas City Southern.

Figure 11. KCS Rail Routes Showing other Class I Rail Routes

For Canadian National, KCS connection provides:

- Canadian National has routes from both New Orleans and Mobile north through Jackson. The KCS connection from Gulfport to Hattiesburg would provide an alternative for all destinations to the north from New Orleans and Mobile
- Use of the KCS link would require KCS to share service rather than services solely on CN routes

Summary of Rail Transportation

The upgraded KCS rail link between Gulfport and Hattiesburg is a necessity for Gulfport to be able to competitively serve U.S. inland regions from Gulf Coast states north to the U.S. Midwest. However, this development alone will not be sufficient to guarantee success in reaching these markets because the rail link will need to offer competitive advantages to the railroads involved in providing services. Shared service between KCS and either NS or CN may not provide significant incentives to the NS or CN partners to induce shifts from current ports and routes.

Ocean Carrier Services and Country Origins

In addition to shifts in inland transportation services, Gulfport will need to induce ocean carriers to modify their services to include calls at Gulfport, either by adding Gulfport to an existing service rotation or by replacing another port on a service. Given that Gulfport has established services from Central America provided by Dole, Chiquita, and Crowley, such new service patterns will need to include links from the Caribbean or South America if Gulfport is to increase its share of the overall Americas market.

Figure 12 displays a South American service offered by one international carrier. As noted earlier most such services include Houston as a primary port of call. In the example service the next port of call is New Orleans.



Figure 12. Hapag-Lloyd Liner Service

Americas Growth Scenario

In addition to potential growth in Americas trade included in the High Growth scenario described earlier, growth in Gulfport's market share could also occur by attracting new container services from the Caribbean or from large South American markets. Whether from current regional markets or from reaching new regional markets, growth in Gulfport volumes from America's trade will likely depend on:

- Successfully capitalizing on Gulfport's improved rail connections to U.S. inland markets
- Inducing modifications to liner companies service patterns

These developments are likely to happen in concert, with ocean carriers and railroads cooperating to improve competitive overall services in response to market developments.

Gulfport currently handles about 1.4% of total U.S. waterborne imports from the Americas, largely in banana and apparel imports from Central America. If Gulfport could double its share of total America's imports in 2020 this would result in new container volumes of about 200,000 TEUs in that year. Given market growth this new volume would increase by 300,000 TEUs by 2030 and 400,000 TEUs by 2040. While a small portion of this share increase could be won from Atlantic Coast and Florida ports, most of this increase in share would likely need to be gained in competition with neighboring Gulf Coast ports including Houston.

Optimistic Growth Scenario Summary

Based on the analyses outlined above, the optimistic growth scenario includes potential new volume in America's trade including that assumed in the high growth scenario, but no growth from Northeast Asia or European trade. The optimistic growth scenario shows total container volumes growing to just under 1 million TEUs in 2040 and 1.7 million TEUs in 2060 (Figure 13).

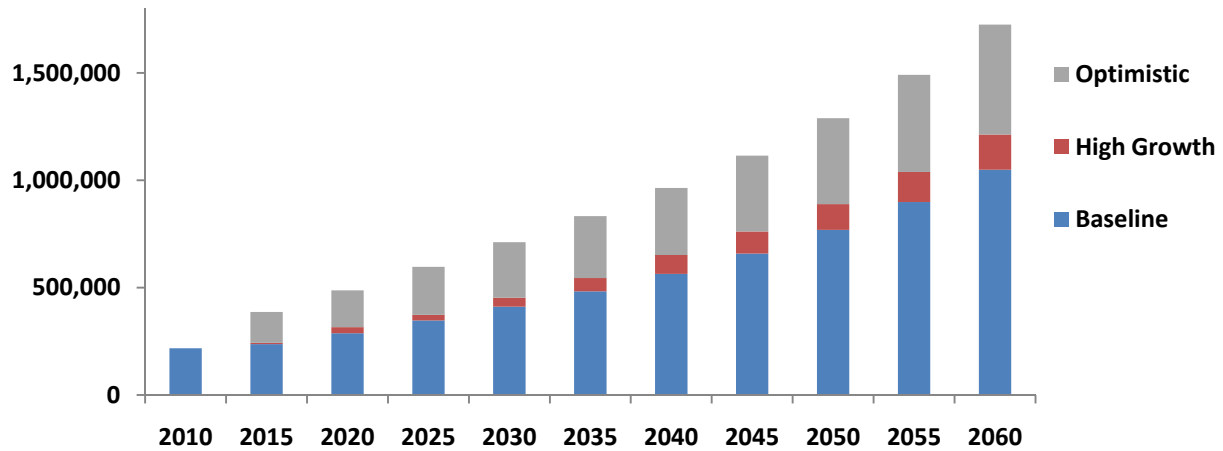
VII. PROJECTION SUMMARY

A baseline projection for Gulfport's container volume shows average annual growth of 3.3% through 2040, largely based on increasing imports from Central America, i.e., growth in banana and apparel imports. TEU volumes would total 0.6 million in 2040 growing to 1.0 million in 2060.

A low growth projection of container volumes is based on relatively low growth of 2.8% in current markets through 2040. TEU volumes would total under 0.5 million in 2040 increasing to 0.9 million in 2060.

A high growth scenario of container volumes is based on higher growth of 3.8% through 2040. TEU volumes would total 0.7 million in 2040 and 1.2 million in 2060.

An optimistic view of container volumes is based not on capturing U.S. imports from Northeast Asia or Europe, but rather on a doubling in Gulfport's share of imports from the Caribbean, Central America, and South America. Such share increases would require successful competition with other Central Gulf ports, in part based on improved capabilities for reaching inland markets by rail. TEU volumes would reach just under 1.0 million in 2040 and 1.7 million in 2060.



Source: PB analysis.

Figure 13. Optimistic Growth Scenario for Gulfport Container Volumes in TEUs

Appendix

The Freight Analysis Framework, Version 3: Overview of the FAF3 National Freight Flow Tables

The Freight Analysis Framework, Version 3: Overview of the FAF³ National Freight Flow Tables

PREPARED FOR:
FEDERAL HIGHWAY ADMINISTRATION
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1. Introduction

1.1 Purpose of This Document

This document provides an overview of how the origin-destination-commodity-mode (ODCM) annual freight flows matrix developed under the Freight Analysis Framework, Version 3 (FAF³) program. FAF³ is a Federal Highway Administration (FHWA) funded and managed data and analysis program that provides estimates of the total volumes of freight moved into, out of and within the United States, between individual states, major metropolitan areas, sub-state regions, and major international gateways. The FAF³ database is constructed by Oak Ridge National Laboratory (ORNL). Staff at MacroSys contributed to the development of a number of industrial sector-specific commodity flow estimates. Staff at Battelle Memorial Institute, and at IHS Global Insight have also developed FAF³ data products that derive from the 2007 freight flow matrices described in this report.

This present document is devoted to describing how the base year, 2007 annual tonnage and dollar valued flows are estimated in the FAF³ ODCM matrix. The document is labeled an overview because a detailed description of the flow matrix building procedure is very lengthy. This present document should suffice the majority of readers interested in knowing the basics of where the flow estimates come from. More detailed descriptions of specific flow estimation components are provided for those wishing to go further into the process. Separate FAF³ documents also describe how these flows are projected into future years, and how these base and forecast year flows are then converted into vehicle/vessel traffic volumes and assigned to (i.e. routed over) individual links and routes within the US national highway, rail and waterway networks.

1.2 FAF³ Data Products

FAF³ data products are the result of merging datasets from a large number of different sources. The principal data products developed under the FAF³ umbrella are the following:

- A set of annual freight flow matrices, reported in annual tonnages and annual dollar value of goods transported, for calendar year 2007 for the United States,
- Based on these base year flow estimates, a set of forecast year freight flow matrices, projected out to calendar year 2040,
- A set of annual freight tonnage and vehicle/vessel movement volumes assigned to specific links and routes over the United States multimodal truck-rail-waterways transportation network, based on these base year 2007 and forecast year 2040 flow estimates.

Based on these estimated freight flows and their network assignments, a set of annual freight tonnage, dollar value, and ton-mileage statistics, broken down by mode of transport and commodity class are also developed.

Figure 1.1 show the functional linkage between these various FAF³ data products, starting with the creation of the calendar year 2007 FAF³ national freight flows matrix. Also shown in Figure 1.1 is a new data product coming out of the FAF³ effort. This is not a data set per se, but an on-line, web-based tool for extracting data elements from the FAF³ database and constructing useful data tables on a regional, modal and/or commodity specific basis.

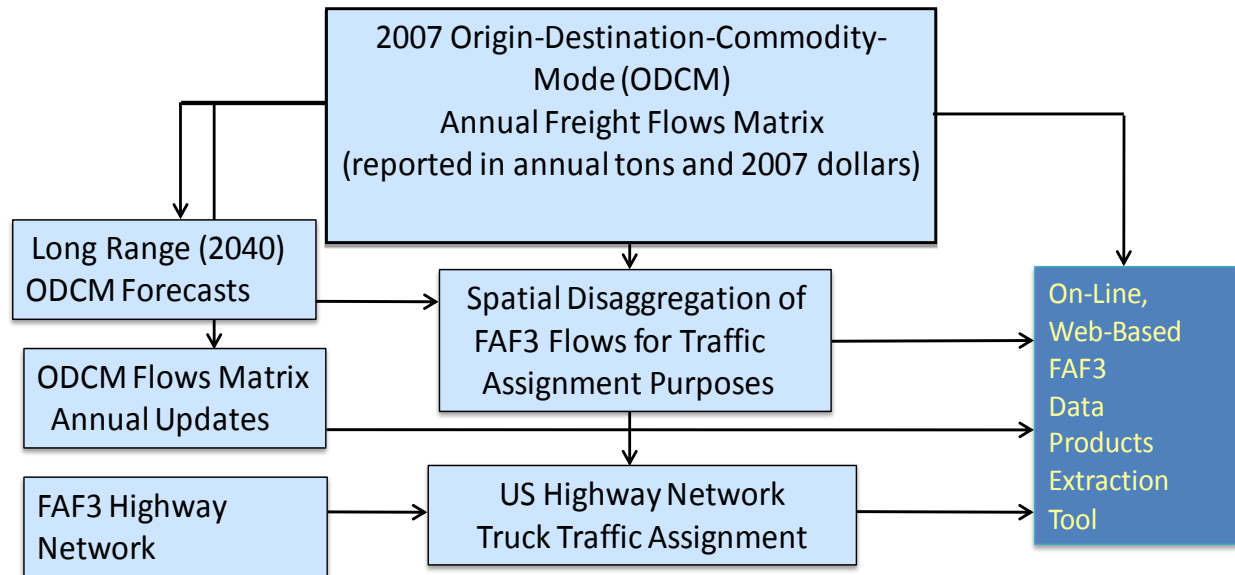


Figure 1.1 Principal FAF³ Data Products

Freight origin-to-destination (O-D) movements are estimated in FAF³ on both an annual tonnage and annual dollar value basis, for calendar year 2007. These estimates are then used as the basis for developing both annual *provisional* updates and as the starting point for a set of longer-range freight movement forecasts, reported at five year intervals from 2015 out to year 2040. The principal dimensions of these FAF³ *Freight Flow Matrices* are:

- Shipment origination region (O),
- Shipment destination region (D),
- The class of commodity being transported (C), and
- The mode of transportation used (M).

The FAF³ freight flows matrix is made up of 131 Origin (O) x 131 Destination (D) x 43 Commodity Class (C) x 8 Modal Category (M) data cells, for each of 2 reporting metrics, annual tons and annual dollar values.

1.3 Links to Technical Documentation

FAF³ is the third database of its kind, with the FAF¹ database providing similar freight data products based on calendar year 1997 data, and FAF² providing freight data products based on calendar year 2002 data. Since the very first FAF effort, a number of changes in both data

products and in the sources of the data used to produce them have taken place. A description these earlier data products, along with the FAF³ data products, can be found at the following FHWA website:

http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm

This site also guides the user to the *FAF³ on-line Data Extraction Tool*, which can also be accessed directly at:

<http://cta-gis.ornl.gov/faf/>

At this site a user can customize and download a variety of freight flow tables directly from the FAF³ database. Interactive links are also provided to FAF³ Data Documentation, Data Summary, and maps.. Users can also download the entire FAF³ 2007 regional database in either Microsoft Access 2003 (125MB) or in CSV (100MB) format.

1.4 Improvements in Reporting Introduced with FAF³

With this latest version of the FAF a number of improvements to the commodity flow matrix have been possible over previous versions. These include:

- A roughly doubling of the number of U.S. shipping establishments sampled as part of the 2007 U.S. Commodity Flow Survey (from some 50,000 establishments in 2002, to approximately 100,000 establishments surveyed in 2007);¹
- The use of PIERS data to support improved estimates of the internal to the U.S. allocations of imports and exports to FAF domestic zones of freight origination (for U.S. exports) and destinations (for U.S. imports);
- Incorporation of additional federal datasets within an improved FAF³ log-linear modeling/iterative proportional fitting algorithm, as well as the development of the Out-of-Scope estimates;
- Greater use of U.S. inter-industry input-output ('use' and 'make') coefficients in the development of the FAF³ out-of-scope (to the 2007 CFS) commodity flow estimates;
- FAF³ provides an O-D specific treatment of natural gas products, which were evaluated only at the level of national or broad regional activity totals in FAF²; and
- The ability to access FAF³ data products via a user friendly web-based data set construction and download tool (cf. Section 1.3 above).

¹ For changes in the CFS between 2002 and 2007 see the following Bureau of Transportation Statistics website: http://www.bts.gov/help/commodity_flow_survey.html#diff_2007_2002

2. FAF³ Geography, Commodity and Modal Classes

2.1 Geography

The 2007 CFS commodity flow tables are based on a revised geography that contains 11 additional traffic analysis regions, for a total of 123 domestic regions in all. FAF³ uses the same geography. Figure 2.1 shows the boundaries of the 123 domestic FAF³ flow analysis regions, also referred to as FAF³ analysis zones.

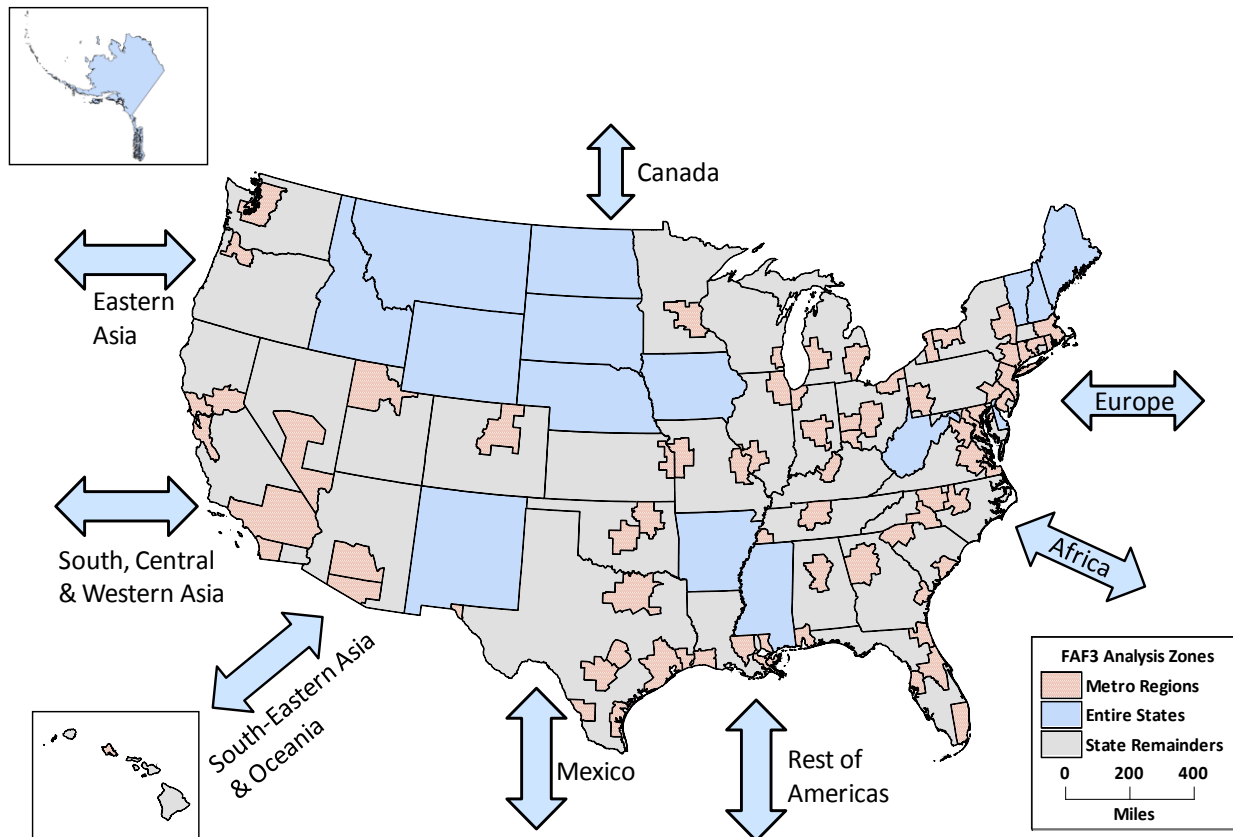


Figure 2.1 FAF³ Geography

Three subsets of regions are highlighted: 74 metropolitan area determined regions, 33 regions made up of state remainders, representing a state's territory outside these metropolitan regions, and 16 regions identified as entire states, within which no FAF³ metropolitan regions exist.

Note that metropolitan regions do not cross State boundaries: so that the Chicago, Kansas City, Philadelphia, and St. Louis metros are split into two state-specific FAF³ regions, while the New York and Washington metropolitan areas are split into three distinct zones. To avoid crossing State boundaries the metropolitan areas of Atlanta (GA), Boston (MA), Charlotte (NC), Louisville (KY), Memphis (TN), Minneapolis-St. Paul (MN), Portland (OR), Providence (RI), Sacramento (CA), and Virginia Beach (VA) are each defined by the state in which most of the

metro areas' population resides and economic activity takes place. Also shown in Figure 2.1 are the 8 world regions that act as the origination and destination points for U.S. exported and imported freight. In addition to flows between the U.S. and Canada and the U.S. and Mexico, flows between the U.S. and the remaining six foreign FAF³ regions are based on an allocation of countries to their respective United Nations geographic region.²

2.2 Commodity Classes

FAF3 reports annual tonnage and dollar valued freight flows using the same 43 2-digit Standard Classification of Transported Goods (SCTG) classes used by the 2007 U.S. Commodity Flow Survey (CFS).

Table 2.1 FAF³ Commodity Classes

SCTG	Commodity	SCTG	Commodity	SCTG	Commodity
01	Live animals/fish	15	Coal	29	Printed products
02	Cereal grains	16	Crude petroleum	30	Textiles/leather
03	Other agricultural products.	17	Gasoline	31	Nonmetal mineral products
04	Animal feed	18	Fuel oils	32	Base metals
05	Meat/seafood	19	Coal-n.e.c.	33	Articles-base metal
06	Milled grain prods.	20	Basic chemicals	34	Machinery
07	Other foodstuffs	21	Pharmaceuticals	35	Electronics
08	Alcoholic beverages	22	Fertilizers	36	Motorized vehicles
09	Tobacco prods.	23	Chemical prods.	37	Transport equipment
10	Building stone	24	Plastics/rubber	38	Precision instruments
11	Natural sands	25	Logs	39	Furniture
12	Gravel	26	Wood products	40	Misc. mfg. products.
13	Nonmetallic minerals	27	Newsprint/paper	41	Waste/scrap
14	Metallic ores	28	Paper articles	43	Mixed freight
				99	Commodity unknown

² See <http://unstats.un.org/unsd/methods/m49/m49regin.htm> for these country-to-region allocations.

2.3 Transportation Modes

FAF³ flows are also broken down by 8` modes of transportation. Table 2.2 lists these mode and commodity classes.

The “multiple modes and mail” category includes truck-rail, truck-water, and rail-water intermodal shipments involving one or more end-to-end transfers of cargo between two different modes. Detailed SCTG code definitions can be downloaded at either of the following Census and Bureau of Transportation Statistics websites:

<http://www.census.gov/svsd/www/cfsdat/2002data/cfs021200.pdf>

http://www.bts.gov/publications/commodity_flow_survey/survey_materials/pdf/sctg_booklet.pdf

Appendix A describes how these CFS-based regional, modal, and commodity class definitions differ from those used by FAF².

Table 2.2 FAF³ Mode Classes

Mode Identification	Mode Name	Mode Description
1	Truck	Includes private and for-hire truck. Private trucks are owned or operated by shippers, and exclude personal use vehicles hauling over-the-counter purchases from retail establishments.
2	Rail	Any common carrier or private railroad.
3	Water	Includes shallow draft, deep draft and Great Lakes shipments.
4	Air (includes truck-air)	Includes shipments typically weighing more than 100 pounds that move by air or a combination of truck and air in commercial or private aircraft. Includes air freight and air express. Shipments typically weighing 100 pounds or less are classified with <i>Multiple Modes and Mail</i>
5	Multiple Modes and Mail	Includes shipments by multiple modes and by parcel delivery services, U.S. Postal Service, or couriers. This category is not limited to containerized or trailer-on-flatcar shipments.
6	Pipeline	Includes flows from offshore wells to land, which are counted as water moves by the U.S. Army Corps of Engineers.
7	Other and Unknown	Includes flyaway aircraft, vessels, and vehicles moving under their own power from the manufacturer to a customer and not carrying any freight, unknown, and miscellaneous other modes of transport.
8	No Domestic Mode	A ‘No Domestic Mode’ category is used to capture petroleum imports that go directly from foreign, inbound ships to an on-shore US refinery. This is done to ensure a proper accounting when foreign and domestic flows are summed, while avoiding assigning flows to the domestic transportation network that do not use it.

3. The Flow Matrix Construction Process

3.1 Overview

The FAF³ modeling process draws from many data sources but the most important is the U.S. Commodity Flow Survey.(CFS). Figure 3.1 shows the principal types of data used to construct the FAF³ ODCM freight flows matrix. This matrix construction process begins with the data reported by the 2007 CFS³, adopting both the CFS definitions for the 123 internal to the U.S. freight analysis zones and the same 43 SCTG 2-digit commodity classes, but using a modification of CFS modal definitions. Each of these three data dimensions is elaborated on below.

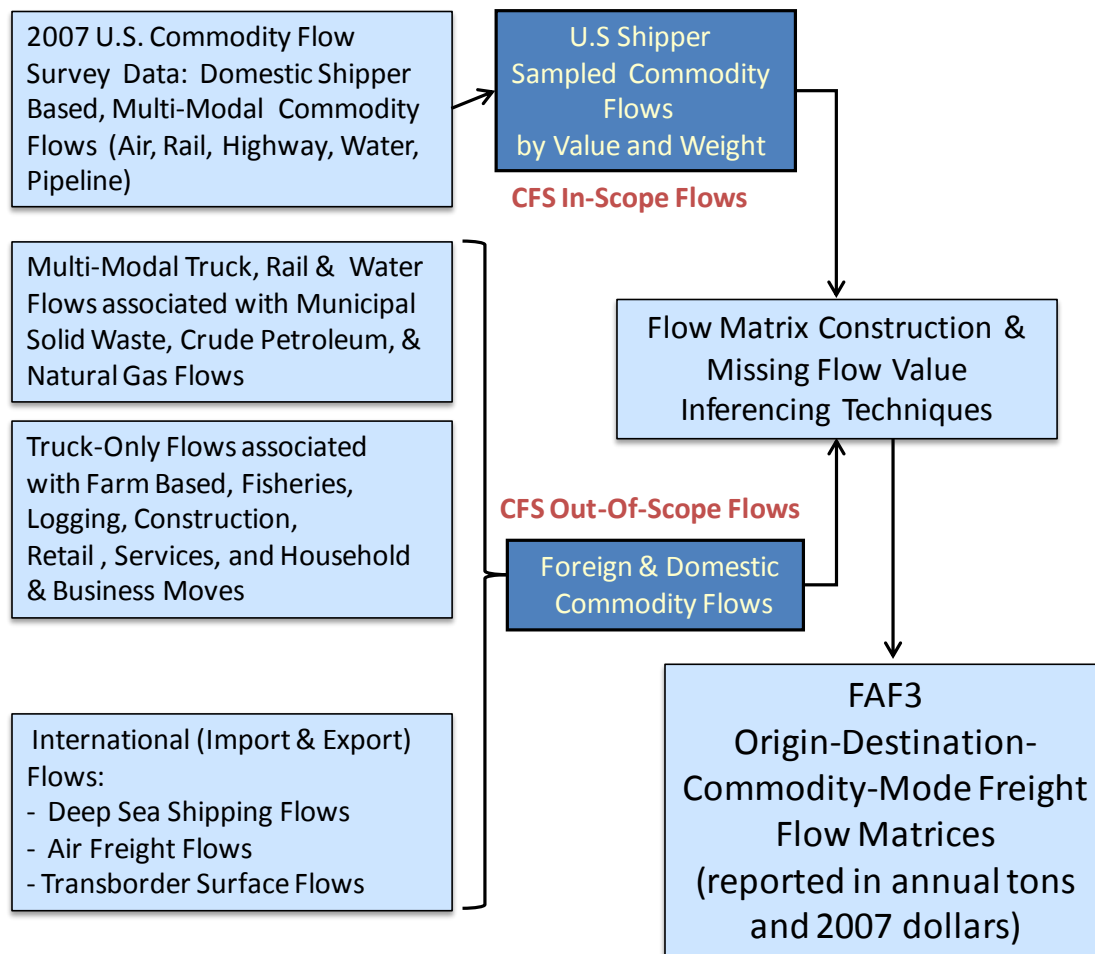


Figure 3.1 Overview of the FAF³ Freight Flow Matrix Construction Process

³For the details of how the 2007 CFS survey methodology, and for on-line access to the public domain CFS data products, go to: http://www.bts.gov/publications/commodity_flow_survey/

The CFS itself is conducted every 5 years as part of the U.S. Economic Census, with major funding for the survey provided by the Bureau of Transportation Statistics (BTS). Data are collected on all shipments from the surveyed establishment for an entire week in each of the four quarters of the census year. In 2007, about twice as many establishment samples were recorded as in 2002.

The CFS represents the best basis for FAF construction because it provides shipper sampled, and subsequently expanded estimates of both tons shipped and dollar value trades within and between all US regions for all modes of freight transportation. However, the CFS has a number of well researched weaknesses that require considerable additional effort in order to construct a complete accounting of freight movements within the United States (see TRB, 2006). First, the CFS does not report imports, while CFS reporting of export flows is also subject to data quality issues resulting from limited sample size. Second, the CFS also either does not collect data from the following freight generating and receiving industries, or collects insufficient data to cover the industries in a comprehensive manner:

- Truck, rail and pipeline flows of crude petroleum, and natural gas,
- Truck freight shipments associated with farm-based, fishery, logging, construction, retail, services, municipal solid waste, and household and business moves, and.
- Imported and exported goods transported by ship, air, and trans-border land (truck, rail) modes.

In FAF³ these industries produce what are referred to in Figure 3.1 as Non-CFS or Out-Of-Scope (OOS) to the CFS freight flows. Their estimation requires a good deal of data collection and integration into the larger flow matrix generation process. The data sources for these OOS flows are for the most part derived from freight carrier reported data sources, in some cases requiring the use of secondary or indirect data sources, such as location specific measures of industrial activity, employment or population, to allocate flows to specific geographic regions. These OOS flows represent some 32% of all U.S. freight movements measured on an annual tonnage basis. Developing OOS flow estimates represents a considerable effort, with different commodity classes requiring very different, typically multi-step treatments: including the use of both spatial and commodity class “crosswalks” that convert mode and industry class specific estimates from their native coding categories into FAF³ regional and commodity class breakdowns.

3.2 Modeling to Enhance CFS In-Scope Flows

3.2.1 CFS Data Gaps and Data Tables

The 2007 CFS is a large and very sparse matrix of annual tonnage and dollar valued freight shipment volumes, with many individual cells assigned a value of value of zero tons and zero dollars of freight shipped during the calendar year. The complete set of 2007 CFS data products

includes a large number of different data matrices.⁴ This includes the most detailed of the published matrices, Table CF0700A25, which reports annual tons, dollar values, and also ton-miles shipped by state of origin, state of destination, mode and 2-digit commodity class.⁵ Although these are the four flow dimensions needed for the FAF this matrix contains many data gaps, and reports only state-to-state shipment totals that need to be assigned in some manner to FAF region-to-region flows. Fortunately, other CFS tables provide 1, 2 and 3 dimensional looks at this same data, including marginal totals at the FAF regional level that do not suffer to the same extent from data suppression. Without going through the contents of each CFS data table in turn, these gaps in the 2007 CFS coverage can be summarized as follows:

- Annual O-D commodity flow estimates exist but some are missing either a modal or commodity breakdown, or both,
- Modal share estimates exist but lack the geographic and/or commodity detail required of the FAF³ flows matrix, and
- Data on shipment lengths exists, by mode and/or commodity, but with little or no linkage to either State or FAF³ regional O-D geography.

In many instances data is missing or suppressed at the 2- or 3-, as well as 4-dimensional level of flow resolution. That is, we have a flow matrix that contains a variety of levels of coverage, with many data gaps needing to be filled.

While many of these zero valued cells are accurate, CFS sample size limitations may also be responsible for missing some of these flows at the origin-destination-commodity-mode level of resolution sought by the FAF; or for creating flow estimates that have such high variability (sampling error) that the US Census Bureau chose to suppress their values. Where such suppression occurs in the CFS a cell value has been replaced by the letter ‘S’. In some cases ‘S’ reported cells may represent quite large freight flows in the real world, because a large coefficient of variation does not necessarily mean that we have only small O-D flows to deal with. For FAF reporting purposes an estimate is desired for these suppressed cell values, and also for any zero valued cells where limited CFS sampling has failed to produce a positive flow estimate, but where freight is likely being shipped.⁶ The question the FAF has to answer is not

⁴ http://www.bts.gov/publications/commodity_flow_survey/ Click on “Interactive tables.”

⁵ <http://www.census.gov/svsd/www/02CFSdata.html>

⁶ Reporting of individual CFS cell values may also be suppressed to avoid disclosing information about an individual company’s activity. For the CFS, the primary method of disclosure avoidance is Noise Infusion: Noise infusion is a method of disclosure avoidance in which values for each shipment are perturbed prior to tabulation by applying a random noise multiplier. Disclosure protection is accomplished in a manner that causes the vast majority of cell values to be perturbed by at most a few percentage points. In certain circumstances, some individual cells may be suppressed on a case by case basis for additional disclosure avoidance purposes. Such cell values have their flow values replaced by the letter ‘D’ in published CFS tables.

http://www.bts.gov/publications/commodity_flow_survey/def_terms/index.html#samplingerror

only what size each of these flows should be, but also, which of the many zero valued cells ought to contain a positive flow at all.

3.2.2 Log-Linear Modeling of Missing Cell Values

The procedure used for estimating these missing cell values is shown in Figure 3.2. This figure is a high level treatment of the problem. The following description provides an overview of the major data steps in this data modeling process.

In FAF³, missing 2007 CFS cell values are first of all estimated using a six-dimensional log-linear model. The first four of these dimensions are the above-defined FAF origin region (O), FAF destination region (D), FAF commodity class (C) and FAF mode of transport (M). To this are added two additional dimensions:

- A ‘freight metrics’ dimension, U, defined by the two classes of metric reported by the CFS, i.e. tonnage ($u = 1$) and dollar value of freight moved ($u = 2$); and
- A data source’ dimension, S, that captures four different classes (= sources) of freight flow estimates, i.e. the 2007 CFS ($s = 1$), the 2002 CFS ($s = 2$), the 2007 Railcar Waybill dataset ($s = 3$), and the 2007 Waterborne Commerce dataset ($s = 4$).

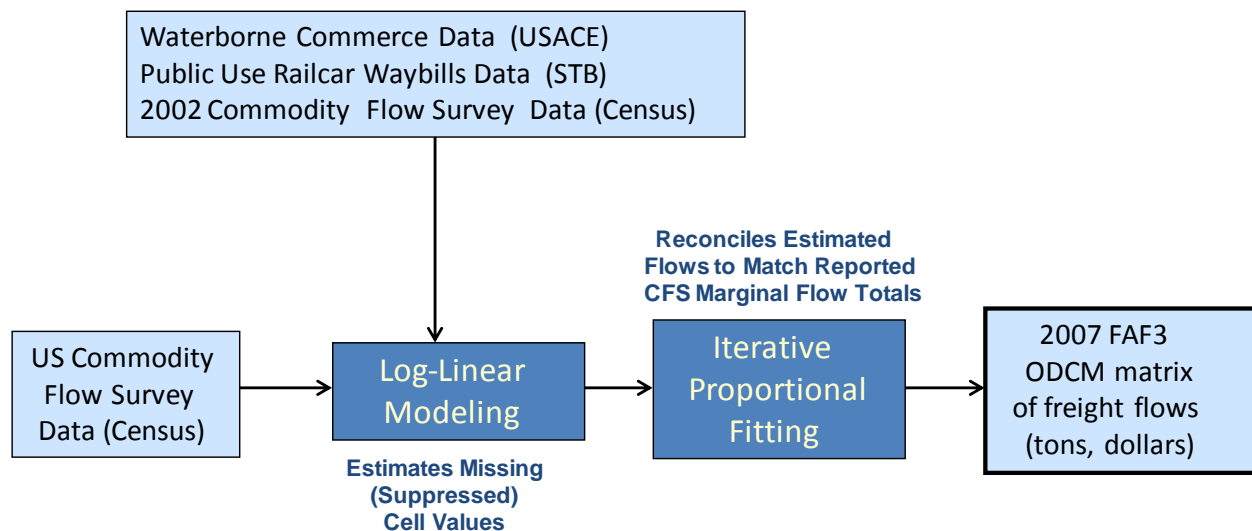


Figure 3.2 Estimation of Missing Cell Values in the 2007 US Commodity Flow Survey

Zero valued cells in the 2007 CFS can be categorized as either “structural” or sampling zeros. For example, truck commodity flows between Hawaii and mainland US regions is an obvious structural zero. Sampling zeros are divisible two types:

1. Cells where no sample data was obtained by the 2007 CFS, but flows may exist; and

2. Cells where the volume of freight sampled was so small that it fell below the CFS reporting threshold, i.e. below 500 tons, or below half a million dollars, and was therefore rounded down to '0' in the CFS published tables.

In particular, a large number of CFS cells have had their value suppressed, for either confidentiality or statistical robustness reasons. For example, cell values are suppressed reported in the 2007 CFS if the coefficient of variation associated with the cell estimate exceeds 50%. The method used for estimating these suppressed, and therefore, missing cells values in the CFS flow matrix is a combination of log-linear modeling (LLM) and iterative proportional fitting (IPF). This LLM/IPF procedure was selected because it has the following characteristics:

1. It makes extensive use of existing data within the matrix in the estimation of missing cell values,
2. It offers the ability to fill in missing cell values while maintaining reported marginal flow totals and observed cell values across all dimensions of the matrix,
3. It has the ability to handle missing values at multiple levels of data aggregation, and
4. It offers the ability to bring different, including non-CFS sources of flow estimates, into the solution, including completely new one, two, and three-dimensional data tables, as needed.

This last characteristic has been exploited extensively for the first time in developing the FAF³ freight flows matrix, and represents a major enhancement to the modeling process used in the previous flow matrix generation process. Specifically, flows reported by two carrier-reported, mode specific datasets are used to help the FAF³ flows matrix capture potentially missing or under-represented flow estimates. These are:

1. Calendar year 2007 annual rail flow volumes (tonnages) reported in the Surface Transportation Board's (STB) public use railcar waybills⁷, and
2. Calendar year 2007 annual flow volumes (tonnages) reported in the US Army Corps of Engineers Waterborne commerce dataset.⁸

In addition, data from the 2002 CFS is also used to look for potentially positive, but zero valued (i.e. sampling zero) flow cells.

In practice, each of these data sources is treated as a component of a sixth dimension in an expanded FAF³ freight flows matrix.⁹ Where a positive cell value is reported in any of these data

⁷ Accessible via http://www.stb.dot.gov/stb/industry/econ_waybill.html

⁸ Accessible via <http://www.iwr.usace.army.mil/ndc/data/data1.htm>

⁹ By housing these alternative modal data sources within a single dimension of the matrix in this manner we are also allowing, without loss of generality, for the application of more sophisticated across the board CFS + non-CFS weighting schemes in the future.

sources, these cells are subsequently assigned a positive value by the LLM/IPF routine, from which a maximum likelihood estimate of that flow's volume is estimated.

The complete FAF³ commodity flow model, referred to as the “Log-Linear Model” in Figure 3.2, has the following form:

$$\begin{aligned} \text{Ln}(F^{\text{ODCMUS}}) = & \lambda_0 + \lambda^{\text{O}} + \lambda^{\text{D}} + \lambda^{\text{M}} + \lambda^{\text{C}} + \lambda^{\text{U}} + \lambda^{\text{S}} + \lambda^{\text{OD}} + \lambda^{\text{OC}} + \lambda^{\text{OM}} + \lambda^{\text{OU}} + \lambda^{\text{DC}} + \\ & \lambda^{\text{DM}} + \lambda^{\text{DU}} + \lambda^{\text{CM}} + \lambda^{\text{CU}} + \lambda^{\text{MU}} + \lambda^{\text{OS}} + \lambda^{\text{DS}} + \lambda^{\text{CS}} + \lambda^{\text{MS}} + \lambda^{\text{US}} + \lambda^{\text{ODC}} + \lambda^{\text{ODM}} + \lambda^{\text{ODU}} + \lambda^{\text{OCM}} \\ & + \lambda^{\text{OCU}} + \lambda^{\text{OMU}} + \lambda^{\text{DCM}} + \lambda^{\text{DCU}} + \lambda^{\text{DMU}} + \lambda^{\text{CMU}} + \lambda^{\text{ODS}} + \lambda^{\text{OCS}} + \lambda^{\text{OMS}} + \lambda^{\text{OUS}} + \lambda^{\text{DCS}} + \lambda^{\text{DMS}} + \\ & \lambda^{\text{DUS}} + \lambda^{\text{CMS}} + \lambda^{\text{CUS}} + \lambda^{\text{MUS}} + \lambda^{\text{ODCM}} + \lambda^{\text{ODCU}} + \lambda^{\text{ODCS}} + \lambda^{\text{ODMU}} + \lambda^{\text{ODMS}} + \lambda^{\text{ODUS}} + \lambda^{\text{OCMU}} + \lambda^{\text{OCMS}} \\ & + \lambda^{\text{OCUS}} + \lambda^{\text{OMUS}} + \lambda^{\text{DCMU}} + \lambda^{\text{DCMS}} + \lambda^{\text{DCUS}} + \lambda^{\text{DMUS}} + \lambda^{\text{CMUS}} + \lambda^{\text{ODCMU}} + \lambda^{\text{ODCMS}} + \lambda^{\text{ODMUS}} + \\ & \lambda^{\text{ODCUS}} + \lambda^{\text{OCMUS}} + \lambda^{\text{DCMUS}} + \lambda^{\text{ODCMUS}} \end{aligned}$$

where $\text{Ln}(F^{\text{ODCMUS}})$ is the model estimated natural log (log to the base e) annual volume of commodity ‘C’ moved by mode ‘M’ between FAF³ origin zone ‘O’ and FAF³ destination zone ‘D’ in 2007, measured in units ‘U’ (i.e U=1 for annual tons, U=2 for annual dollar value of the freight moved), and found in data source ‘S’ (e.g. S = 1 for CFS 2007, S=2 for CFS 2002, S= 3 for 2007 Railcar Waybills, and S = 4 for 2007 Waterborne Commerce).

The λ 's represent the model parameters to be estimated, often termed the (natural log of the) *effects* of the different dimensions, or combinations of dimensions, on the resulting flow estimates. For example, λ^{OM} represents the effect of shipment origin O and mode M, λ^{ODCM} represents a four-way, O,D,C,M interaction effect, and λ_0 represents the grand mean of all these effects. Parameters representing all possible levels and combinations of the matrix dimensions O,D,C,M,U and S are used to fit the data to what is usually termed a *saturated* model that tries to get the most out of the statistical relationships represented by the data sources. This equation is translated into an additive, natural log form for solution (i.e. for computational) purposes. In practice, many of the λ 's are set to a value of 0.0. For example, since both the 2007 railcar waybill and waterborne commerce flows are only reported in tons, all dollar valued λ 's associated with these two data sources = 0.0 and play no further part in the estimation process.

3.2.3 Iterative Proportional Fitting (IPF) to CFS Marginal Totals

Once all of the log-linear model's λ *effects* have been computed, they are used to generate a positive value of each zero valued flow cell in the original 2007 CFS commodity flow matrix. In each case, where a zero valued cell is found it is replaced with an estimate based on the above multiplicative log-linear model. Three additional steps are then taken:

- 1) Cells considered to be structural zeros are returned to a value of 0.0.
- 2) To further assist with filling in of missing CFS cell values, an additional dataset was provided by the U.S. Bureau of the Census. This is a matrix containing the number of establishments

sampled within each ODCM cell in the matrix, i.e. a set of raw sample responses. If one or more positive responses are identified for a specific cell, then this is taken to imply the presence of some freight movement activity, and it is therefore treated as a sampling zero for the purpose of cell value estimation.

3) A third modification to process then involves the removal of unreasonable dollar per ton estimates caused by biased or limited sampling, in which either the tonnage or the dollar value allocated to a particular cell by the log-linear/IPF modeling process creates a dollar-per-ton ratio that exceeds expected values for the commodity class in question by a significant amount. To prevent this from occurring, a check is made every ten iterations of the IPF to look for such outliers. If one or more are found, an adjustment is made to either the tonnage or dollar value in such a cell and the iterative process re-commenced.

The resulting matrix (now with no missing values) is then adjusted through IPF to comply with known control totals from numerous CFS marginal tables. It is important to note here that after the full LLM/IPF procedure is completed, no 2007 CFS ODCM or higher (3 or 2 dimensional) marginal cell value has been changed if it contained a positive flow value to begin with. Only potentially missing valued cells (of which there are many) are altered by the process.

3.3 Data and Modeling of Non-CFS (Out-of-Scope) Flows

3.3.1 Domestic Flows

U.S. freight shipping establishments in the following industrial sectors were not surveyed as part of the 2007, or previous, US Commodity Flow Surveys. The following out-of-scope (OOS) industries therefore had to be assigned commodity and mode specific O-D flows using other methods:

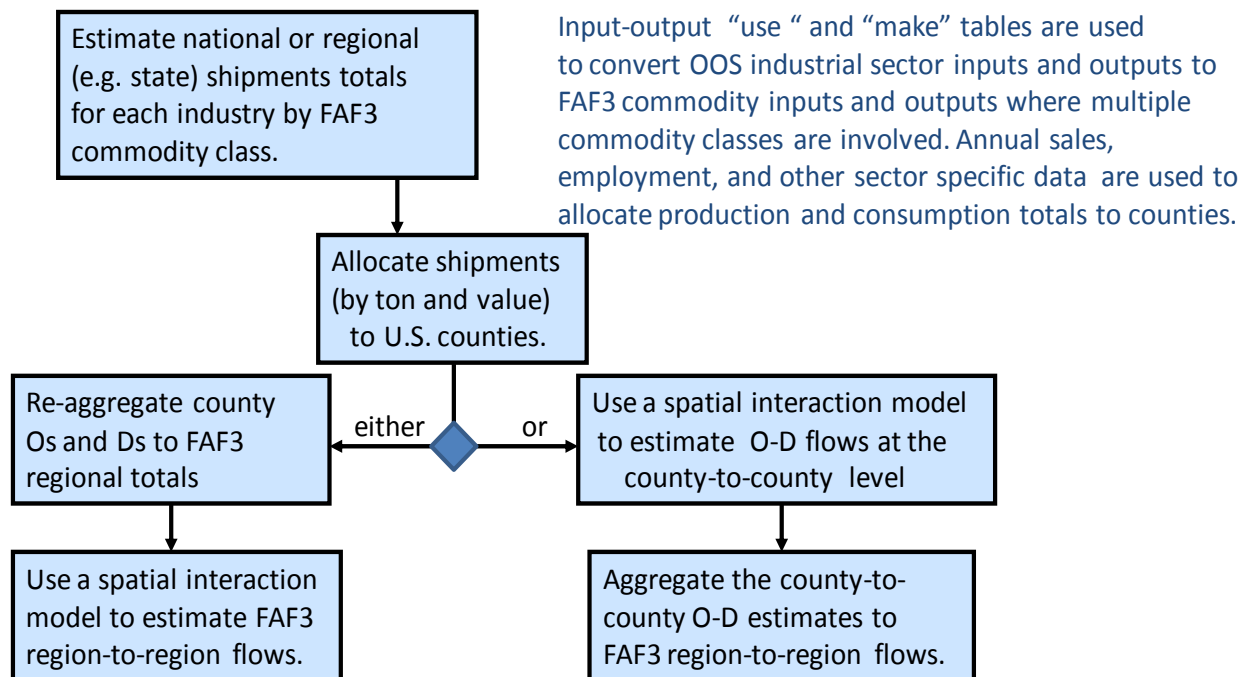
1. Farm Based	6. Retail
2. Fishery	7. Household and Business Moves
3. Logging	8. Municipal Solid Waste
4. Construction	9. Crude Petroleum
5. Services	10. Natural Gas Products

OOS flows were estimated using commodity specific datasets and different computational methods for each industrial class. Where an industrial sector produces O-D flows in more than one commodity class, data from national inter-industry input-output “use” and “make” tables was used to determine how much freight each sector contributes to a specific set of SCTG 2-digit commodity flows. State and county level data on volume of production, industrial or commodity specific sector sales, or industrial sector employment is then used to allocate flows between origins and destinations. Spatial allocation formulas are then used to produce O-D flow volumes. Where truck movements were concerned this occurred in one of two ways. Either county level origin and destination activity totals were determined, and then a spatial interaction model was applied to these county productions and attractions, with subsequent aggregation of inter-county

flows back up to FAF³ region-to-region flow totals. Or county Os and Ds are first of all estimated and aggregated to their FAF³ regional supply and demand totals. These regional totals are then used to estimate O-to-D flows directly at the FAF³ region-to-region level.

The specific form of spatial interaction model used also varied by commodity class. Either a distance decay coefficient is calibrated against an empirically derived average shipping distance, or a simple allocation is made based on market potentials (i.e. on the relative size of a county's or region's demand for a specific commodity). County-level spatial interaction modeling here allows for cross-county flows to be captured that are also cross-FAF³ adjacent regional flows. Use of regional O and D shipment totals prior to spatial interaction modeling occurred where data sources proved more reliable at this less detailed level or geography.

Figure 3.3 shows the general idea. In practice, each industrial sector has its own data gaps and idiosyncrasies that needed to be dealt with.



Note: Data modeling details vary a good deal by industrial sector/commodity class

Figure 3.3 Four Step Process for Generating OOS Truck Freight Flows

The following sections focus on summarizing the datasets used to produce the FAF³ flow estimates. For greater detail on estimation methods, the reader should consult FAF³ industry sector-specific write-ups.

Farm Based Flows

Farm-based agricultural shipments represent one of the most significant out-of-scope areas for CFS. These shipments are almost entirely moved by truck. The vast majority of these shipments represent farm-to-storage elevator (e.g., grains) or farm-to-distribution/processing center (e.g., fruit, livestock) trips, at which point further transportation of these products is captured as part of the CFS sample frame. At the fully national level, the total tonnage of farm-based agricultural shipments constitutes nearly 7% of the 2007 total tonnage moved within the nation, and over 9% of all truck tons shipped. County and state level data published by in U.S. Department of Agriculture's (USDA) 2007 *Census of Agriculture* and the 2008 *Agricultural Statistics* were used to generate FAF³ tons and dollars shipped estimates, supplemented with data from several of USDA's *Statistical Bulletins*.

The dollar value of these farm originating agricultural products were estimated using information obtained from the 2007 *Census of Agriculture* and related publications. Specifically, data provided under the category of "Market value of agricultural products sold"¹⁰ was used as an estimate for total farm-based agricultural shipments. The estimation of tonnages for these out-of-scope shipments was less straightforward. Commodity statistics published in the USDA's 2007 *Census of Agriculture* use a variety of commodity specific units of measurement (e.g., pounds, bushels, hundredweight, barrels, tons, etc). In some cases, different conversion factors, all based on information obtained from *Agriculture Statistics 2008*, were also needed for different commodities using the same basic unit of measurement. For example, the approximate net weight for a bushel of wheat is 60 pounds, while a bushel of husked corn on the ear weighs 70 pounds, and shelled corn weighs in at 56 pounds per bushel on the average. Following these unit conversions, each farm-based agricultural commodity is then placed within its 2-digit SCTG commodity class.

Where a State is divided into more than one FAF³ region, USDA county level data was used and subsequently re-aggregated to FAF³ regional totals. This was done after filling gaps in this county-specific data, by using acreages devoted to a specific crop-growing activity as a surrogate for gaps in direct reporting of crop yields. O-D flows are then estimated, first by summing these county originations to their FAF³ regional totals, then sharing these totals to FAF³ destination regions on the basis of a) truck trip length distributions reported by the 2002 VIUS, and b) using the volumes of agricultural commodity originations reported by the 2007 CFS to allocate these flows. That is, these CFS originations (from the distribution centers, grain elevators, processing centers, etc. located within a CFS region) constitute the first non-farm stop in the agricultural product's supply chain. Hence they represent a good surrogate for the destinations of farm-based shipments. Separate allocations are made on the basis of tons shipped and dollar valued trades.

¹⁰ The "market value of agricultural products sold" category represents the value of products sold which combines total sales not under production contract and total sales under production contract. It is equivalent to total sales. See Appendix B, General Explanation and Census of Agriculture Report Form, in the 2007 *Census of Agriculture* report for further explanation (http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1_Chapter_1_US/usappxb.pdf)

As a result of this process, the annual tons and dollar valued flows between any two FAF³ regions are consistent with both VIUS truck trip length distributions for a specific FAF³ freight originating region and commodity class, and also create a consistency between OOS farm-based flows and the non-farm based agricultural commodity flows reported in the 2007 CFS.

Construction Industry Flows

Shipments originating from activities in the construction sector, including companies or establishments engaged in construction of residential and non-residential buildings, utility systems, roadways and bridges, and from specific trade contractors, are not in-scope for the CFS. It is estimated that this industry transported just under 1.08 billion tons of freight over the course of 2007, valued at \$905.7 million. However, putting a dollar value on such freight is not straight-forward. The primary commodity shipped was debris (included in SCTG 41 under Waste and Scrap), for which the value would be relatively small unless recyclable materials are separated and sold. An estimate of the amount of debris generated by the construction industry was developed based on publications by the U.S. Environmental Protection Agency (EPA) publications,¹¹ the National Demolition Association, Construction Materials Recycling Association, and Gershman, Brickner & Bratton, Inc. Similar dollar to ton conversions for other commodity classes are drawn from the CFS or other industry specific sources.

Data on shipment distances for the industry are limited at best for 2007, and in FAF³ all of these shipments are assumed to be short distance truck movements, most occurring within a single county, and all within the same FAF³ zone. Shipment volumes were assigned to FAF³ regions using sales data from the 2007 Economic Census (EC) where available, and using a combination of 2007 county level employment data from the Census Bureau's County Business Patterns (CBP) dataset, multiplied by Census developed labor productivity rates by industry class at the state level.

Fishery Flows

The CFS omits fishery shipments that move from vessels at the dock/port to the first point of processing or distribution centers. Establishments involved in this data gap are within the NAICS category 114 (fishing, hunting and trapping). Industries in this NAICS sector harvest fish and other wild animals from their natural habitats and are dependent upon a continued supply of the natural resource. Based on statistics published in the *Fisheries of the United States 2008*¹², an annual report prepared by the National Marine Fisheries Service (NMFS) of the National

¹¹ <http://www.epa.gov/osw/conserve/rrr/imr/cdm/pubs/cd-meas.pdf>.

¹² Information obtained from the *Fisheries of the United States 2008* report, published by National Marine fisheries Service, Office of Science and Technology in July 2009, was used to supplement its 2007 report under this analysis. Although 2007 statistics are available in the *Fisheries of the United States 2007*, many are in preliminary forms. The 2008 report provides more updated information on statistics for 2007.

Oceanic and Atmospheric Administration (NOAA), commercial landings by U.S. fishermen at ports in the 50 states were totaled at approximately 4.7 million tons and valued at over \$4 billion in 2007. In addition, catches of Alaska Pollock, Pacific whiting, and other Pacific ground fish that are processed at-sea aboard U.S. vessels in the northeastern Pacific (off Washington, Oregon, and Alaska) are credited as landing to the state nearest to the area of capture. According to NMFS, these at-sea processed fishery products accounted for a total about 1.4 million tons and valued approximately \$19 million in 2007. It is assumed that this freight activity is mostly local, and that all shipments involve intra-regional FAF³ truck-only movements.¹³

Retail Industry Flows

The 2007 CFS also does not cover shipping activities originating from the vast majority of the nation's retail stores. It is estimated that 378.6 million tons of freight were shipped by the U.S. retail industry in 2007, valued at \$624 billion. Based on the U.S. Bureau of Economic Analysis's National Input-Output Make and Use Tables, the retail industry generates commodity flows in most of the FAF³ commodity classes.

Although most of the shipments from retail stores are within the same county, there is a possibility that retailers may transport large items purchased by customers from their warehouses, which may be located in other counties. At the county level this would be an issue, but is less likely to be of concern when aggregating O-D flows from counties up to FAF³ regional totals. An issue with retail industry flows is whether some of these shipments are originated from retailer-owned warehouses that serve retail stores not covered by the CFS. In this case some inter-regional flows might be missing from FAF³ totals. These volumes are believed to be quite small in percentage terms.

Service Industry Flows

This sector covers a wide range of services, including finance and insurance, real estate, rental and leasing, professional, scientific and technical services, administrative support, waste management and remediation services, education services, and health care and social assistance. These industries are typically involved in providing services to the general public, local business establishments, and branches of government, and in toto originate freight shipments in a large number of FAF³ commodity classes. Also not covered by the 2007 CFS are the mail shipments by these service industries. The sector as a whole is estimated to have generated 378.6 million tons of commodity freight in 2007, worth just under an estimated \$504.7 billion. To this is added some 11.4 million tons of mail, valued at \$525.6 billion.

¹³ Based on NMFS published statistics, total imported edible and non-edible fishery products were over 2.4 million tons and worth about \$28.8 billion in 2007. Because imports are categorized as a separate out-of-scope area of the CFS (see Section 3.3.2 in this report), to avoid double counting, imported fishery is not included under this fishery shipment data gap study.

The availability of county level sales data varies by type of service offered. For example, the county level sales data for educational services are released for only 10 states. For real estate and food services, the sales data at the county level are available for 20 states. A first step was therefore to fill in this data gap for those service industries, then sum the sales of individual types of services to obtain an overall sales statistic for each county. Shipment volumes between counties were then estimated as follows (MacroSys, 2010):

- For non-mail shipments, the county level demand for service sector products (i.e. the market potentials for these destination counties) was determined by two factors: (i) the amount of a commodity used by industries according to the Use table in the U.S. I-O model and (ii) industrial employment at counties. Next, a spatial interaction (“gravity”) model was used to distribute flows from each freight generating county to surrounding counties within our across FAF³ regional boundaries.
- For mail shipments, total employment in services at the county level served as a surrogate for market potentials. Since mail is known to be shipped over long as well as short distances across the county, and lacking any empirical data on this distribution, no distance decay effect was applied to this sharing process in FAF³.

Household and Business Move Flows

It is estimated that some 254.3 million tons of freight were moved by the industrial sector, nearly all of it by truck. The value of the goods moved is estimated at just \$30.9 billion. Several sources of data on the volumes of U.S. household and business moves were examined, including the U.S. Census Bureau’s Annual Services Survey and related studies conducted by the American Trucking Association and the American Moving and Storage Association.

All of these shipments are assumed to be truck moves in FAF³. These truck shipments were allocated to counties on the basis of CBP-reported sector employment totals. The shipments are then allocated spatially between county O-D pairs based on IRS reported county level in-migration and out-migration totals. (In the absence of available data on trip length distributions, a distance decay effect was not used in this allocation process).

Logging Flows

Some 372.3 million tons of logs, totaling almost \$9.5 billion by value, are estimated to have been transported in the U.S. as a whole in 2007, of which the vast majority are transported by truck from domestic forests to nearby sawmills and other local sites. County level logging products were estimated by multiplying the year 2007 employment in logging industries, by an average tons per employee multiplier. To allow for logging products being transported across FAF³ regional boundaries, these products were assigned to counties located within a 75 mile radius of the producing county, based on the employment in wood product industries within each county, and upon data collected on the average haul to market distance of logging products (e.g. sawlogs, peeler logs, OSB, pulpwood and rustic fencing).

Municipal Solid Waste Flows

Municipal solid waste (MSW) is not covered in the CFS, and also does not have a specific code in NAICS. The main data sources used for estimating 2007 MSW shipments came from information compiled by Franklin Associates¹⁴ in collaboration with the U.S. EPA,¹⁵ supplemented by information in the *BioCycle* journal¹⁶. Additional, mode specific data was also obtained from the U.S Army Corps of Engineers Waterborne Commerce statistics, and from the Surface Transportation Board's Railcar Waybills sample. As defined by the U.S. EPA, MSW includes the following 'Subtitle D wastes':

- Containers and packaging, such as soft drink bottles and cardboard boxes,
- Durable goods, such as furniture and appliances,
- Nondurable goods, such as newspapers, trash bags, and clothing, and
- Other wastes, such as food scraps and yard trimmings.

It is estimated that 413 million tons of MSW, as defined above, were transported within the U.S. in calendar year 2007. All of this MSW is collected at the source and transported to one of four types of processing facility: local landfills, local incineration facilities, local material recovery facilities, and waste transfer stations where garbage trucks unload MSW for accumulation and transfer to larger transport vehicles (truck, rail, or barge), for more economical long-distance hauling to a final disposal site (Curlee, 2009).

Data on the flows between states was based on work done by McCarthy (2007) for the Congressional Research Service. Combining this work with data from other sources, it is estimated that more than 42% of total state-to-state transfers (i.e. state exports) come from three states—New York, New Jersey, and Illinois, while several other states export more than 10% of the U.S. total across state lines. The District of Columbia exports all of its total MSW generation, while New Jersey exports over 45%, New York exports over 33%, and Maryland over 29%. Additional states that export more than 10% of their MSW include Connecticut, Illinois, Kansas, Massachusetts, Missouri, North Carolina, Vermont, Washington, and West Virginia. More than 46% of all these state exports go to three states—Pennsylvania, Virginia, and Michigan. Only five additional states account for more than 4% of the national total shipments of inter-state MSW—Georgia, Illinois, Indiana, New Jersey, Ohio, and Oregon. Based on ORNL discussions with local officials for the previous, FAF² effort, it appears that the large majority of shipments to adjoining states are essentially local shipments. For example, the city of Memphis ships MSW to Mississippi. Chicago ships tons to Indiana. The District of Columbia ships to Virginia. Also, small to medium sized towns near a state line may ship to an adjoining county across the state line. While these are truck movements, some longer distance shipments are by rail or (much less so) by inland waterway (i.e. by barge). It is estimated that just under 40% of inter-state

¹⁴ <http://www.fal.com/solid-waste-management.html>

¹⁵ <http://www.epa.gov/epawaste/nonhaz/municipal/msw99.htm>

¹⁶ <http://www.jgpress.com/biocyce.htm>

shipments of MSW are by rail (mostly) or barge. This represents less than 4% of all MSW shipments.

The FAF³ MSW estimates also include significant tonnages moving from Maine to New Brunswick, Canada, from Ontario, Canada to Michigan, and a from Ontario to New York state (Curlee, 2009). Allocation of (truck-only) MSW between FAF³ regions below the state level then used county populations to distribute inter-state flows, with subsequent re-aggregation from counties to FAF³ regions. County-to-county O-D flows were estimated using a spatial interaction model, using an average O-D distance of just under 32 miles, derived from the MSW literature. These inter-county flows were then aggregated to their FAF³ region-to-region totals.

Crude Petroleum

It is estimated that the US transported some 744.4 million tons of crude petroleum (crude oil) in 2007, using a variety of modes. This crude was valued at some \$336.4 trillion dollars. These crude oil shipments begin either at domestic oil fields, or from large marine terminals that act as the first domestic storage and transfer point for foreign oil imports. The crude is delivered either to refineries or to long-term storage facilities such as the Strategic Petroleum Reserve.. A great deal of this transport is accomplished by pipeline, and by marine vessels (inland barge and oceangoing tanker), with significant tonnages also moved by rail tanker car and locally by tank truck.

National level crude oil shipment information by transportation mode is based on *Shifts in Petroleum Transportation* published annually by the Association of Oil Pipelines. This report's modal information is in turn based on several other data sources, including:

- Oil Pipelines: Annual Report of oil pipeline companies provided to the Federal Energy Regulatory Commission (FERC Form 6);
- Water Carriers: Waterborne Commerce of the United States, U.S. Army Corps of Engineers, (Part 5, Table 2-2);
- Motor Carriers: Petroleum Tank Truck Carriers Annual Report, American Trucking Association, Inc. and Petroleum Supply Annual, Energy Information Administration (EIA) (Volume 1, Table 46); and
- Railroads: Carload Waybill Statistics, Report TD-1, USDOT, Federal Railroad Administration, and Freight Commodity Statistics, Association of American Railroads (Table A3).

O-D flows of crude petroleum were derived using US DOE/EIA supplied data at various levels of geographic detail, ranging from five broad multi-state PADDs (Petroleum Administration for

Defense Districts)¹⁷ and individual States, to specific refinery locations. This includes data from EIA's Petroleum Supply Annual (EIA, 2010) on:

- Production of Crude oil by PAD District and State,
- Refinery Input of Crude Oil by Refining Districts, and
- Refinery Receipts of Crude Oil by Method of Transportation, by PADD.

Spatial interaction (e.g. “gravity”) models were then used to disaggregate flows down to a State-to-State and FAF region-to-FAF region level. First, U.S. Census' County Business Pattern data for 2007 was used to share total crude production by state down to the county level. This allocation was based on a county's reported total annual payroll for industries classified under NAICS code 211111 – ‘Crude Petroleum and Natural Gas Extraction’.¹⁸ These county activity totals were then aggregated to their respective FAF³ regions. This resulted in 80 different petroleum sourcing regions, serving 50 petroleum refining FAF³ regions. O-to-D allocations between these pairs of regions were then estimated using a distance-decay based spatial interaction model, applied at this broader regional level of resolution.

Natural Gas Products

Delivering natural gas (principally methane, but also smaller volumes of ethane, propane, butane and pentane) is an enormous enterprise. This gas is transported to consumers through more than 300,000 miles of transmission pipelines with the help of vast storage reservoirs and thousands of compressors. This gas is sold to marketers, large commercial and industrial consumers, and distribution companies for delivery to consumers over a network of more than 1.1 million miles of local distribution pipelines.

National Natural Gas flow totals, and O-D region-to-region flows were derived from the EIAs' Natural Gas Annual (EIA, 2010)¹⁹, making use of data at various levels of geographic detail, including:

- Gross Withdrawals and Marketed Production of Natural Gas by State and the Gulf of Mexico,
- Offshore Gross Withdrawals of Natural Gas by State and the Gulf of Mexico,
- Summary of U.S. Natural Gas Imports By Point of Entry, and
- Summary of U.S. Natural Gas Exports By Point of Exit, Natural Gas Annual.

Spatial interaction models were then used, where necessary, to disaggregate flows down to a

¹⁷ The New England, Midwest, East Coast, Gulf Coast, and West Coast PADDs. For specific state allocations to APDDs see: http://www.eia.gov/glossary/index.cfm?id=P#PADD_def

¹⁸ The data is obtained by county level from the County Business Pattern at the U.S. Census Bureau - <http://www.census.gov/econ/cbp/intro.htm>.

¹⁹ See http://tonto.eia.doe.gov/dnav/ng/ng_pub_publist.asp

State-to-State and a FAF region-to-FAF region level.

3.3.2 Import and Export Flows

Imported as well as exported freight flows in FAF³ are constructed from a variety of data sources, each of which must have its flows converted from agency specific commodity codes to FAF³'s 2-digit SCTG codes, as well as have its flows either spatially aggregated or disaggregated to match FAF³ analysis zones. Figure 3.4 provides a top-down view of this process.²⁰ The following sections describe each source data-specific procedure in more detail.

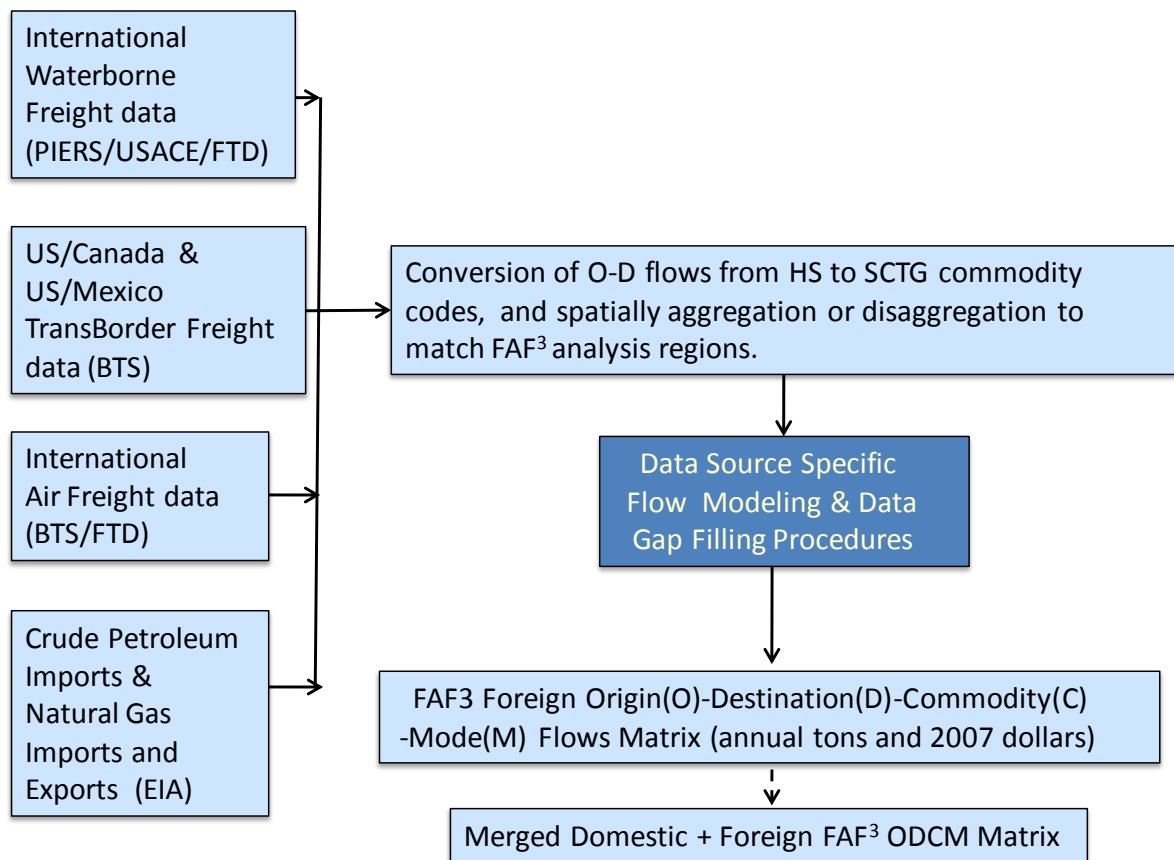


Figure 3.4 FAF3 International (Import/Export) Data Modeling

Waterborne Imports and Exports are derived in FAF³ using four different data sets, each of which provides a different look at the nation's international freight movements by ocean vessels:

²⁰ Although the 2007 CFS does also collect data on export shipments by US establishments, both coverage and statistical accuracy is limited by sample size issues and this data was not used as a source for FAF³ export flow estimates.

- The U.S. Army Corps of Engineers International Waterborne Commerce Database²¹
- The U.S. Census Bureau's Foreign Trade Database²²
- A FAF³-specific extraction of data from the PIERS Import/Export Database²³
- Imported & Exported Petroleum & Natural Gas data from the U.S. Department of Energy's Energy Information Agency (EIA)

The availability of these last two data sources represents a significant enhancement in FAF³, and especially the PIERS dataset, which provided estimates of the internal to the U.S distribution of imported and exported goods. In 2002, the distribution of domestic CFS shipments was used to impute domestic trip ends and modes used in FAF² for every commodity that passed through a seaport. In 2007, information from PIERS was used to impute many of these domestic trip ends, with 2007 CFS data being used to impute the modes used between U.S. seaports and their internal U.S. destinations or origins.

International Air Freight Flows: Data published by the U.S. DOT's Office of Airline Information (OAI), Bureau of Transportation Statistics provided the FAF³ estimates of total tons shipped annually between originating airports (where the cargo is first loaded onto an aircraft) and destination airports (where the cargo is unloaded for final land-based delivery, usually by truck).²⁴ This data is combined with data collected by U.S. Customs on the commodity class and value of international air shipments, as reported by the Foreign Trade Division (FTD) of the U.S. Department of Commerce's Bureau of the Census.²⁵ This FTD dataset includes information on the value,²⁶ quantity, method of transportation, and shipping weights for 9,000 export commodities, 17,000 imported commodities, 240 trading partners, and 45 U.S. Customs Districts.

The OAI and FTD data are combined into a single FAF³ air freight dataset by reconciling differences in the level of spatial and commodity detail to match those required by the FAF. First each airport was assigned to its U.S. county, and each county to both its appropriate U.S. Customs District and FAF³ region, using geographic coordinates data files available from OAI and the Census Bureau. Commodities are reported in the FTD dataset using the 10-digit Harmonized Tariff Schedule (HS Schedule B for exports). This data is aggregated and translated to FAF³'s 43 2-digit SCTG commodity classes using a crosswalk specifically developed for the purpose. Where differences exist between the OAI and FTD flow totals, the OAI database was taken to be definitive for total tons shipped, and the FTD database was used to control the

²¹ <http://www.iwr.usace.army.mil/ndc/data/dataimex.htm>

²² <http://www.census.gov/foreign-trade/reference/products/index.html>

²³ Special tabulations prepared for the FAF³ project by PIERS staff. (<http://www.piers.com/>)

²⁴ T-100 (foreign) market data. http://www.bts.gov/publications/freight_transportation/

²⁵ <http://www.census.gov/foreign-trade/reference/products/index.html>

²⁶ Export values are reported free-alongside-ship (F.A.S.) Import values are reported as customs-insurance-freight (C.I.F) values.

allocation of freight shipments to commodity classes, and to assign value-to-weight ratios to these flows.

U.S.-Canada and U.S.-Mexico Transborder Freight Flows: Truck and rail freight movements between the United States and its NAFTA neighbors Canada and Mexico are derived in FAF³ from the Bureau of Transportation Statistics (BTS) Transborder Freight Database, itself constructed from data collected at border crossings by the U.S. Customs Service. After converting the Harmonized Tariff Schedule (HS) commodity classes in this dataset to FAF³ SCTG classes, County Business Patterns are used to allocate flows reported at the State level to their most likely FAF³ regions within the United States.

Imports and Exports of Natural Gas and Imports of Crude Petroleum: Liquefied Natural Gas (LNG) is imported or exported to/from the U.S. by large tanker ships. The US Department of Energy's Energy Information Administration (EIA) reports annual LNG imports/exports in millions of cubic feet by U.S. seaport of entry/exit. The EIA also reports the annual trade in pipeline supplied natural gas (NG) between the U.S. and Canada and the U.S. and Mexico, also in millions of cubic feet. Reporting here is both by State and by specific U.S. seaport of entry/exit, requiring assignment of flows to seaport-inclusive FAF³ regions.²⁷

EIA databases were also used to estimate crude petroleum imports in FAF³, taking advantage of the fact that crude petroleum imports are reported to the EIA monthly at the company, U.S. seaport of entry/exit, and foreign country level²⁸, allowing the complete movement of imported crude oil from the foreign country (source of commodity), passing through the port (domestic origin), to the refinery (domestic destination) to be estimated. The allocation of these flows to specific modes of transportation was then based on EIA data on crude oil refinery receipts, broken down by mode of transportation (ship, pipeline, rail, barge, truck), and further broken down by domestic versus foreign sources of production.²⁹

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²⁷ Both the EIA's LNG and NG data sources for US Imports/exports can be found at:

http://tonto.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html

²⁸ http://www.eia.doe.gov/oil_gas/petroleum/data_publications/company_level_imports/cli.html

²⁹ http://www.eia.doe.gov/oil_gas/petroleum/data_publications/refinery_capacity_data/refcapacity.html

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Appendix A: Differences in the FAF³ and FAF² Freight Flow Matrices

The FAF³ Analysis Zones are different from the FAF² zones. Since the FAF freight flow matrix is developed around the data supplied by the U.S. Commodity Flow Surveys (CFS) the geography has changed with CFS geography. In 2007 the use of more CFS analysis zones (made possible by the much larger size of the CFS sample) allows the FAF to adopt these CFS zones while maintaining its focus on U.S. coastal analysis zones that both receive and pass on most U.S. imports and exports. This compatibility with the CFS geography should make future development of FAF flow estimates not only less time consuming but also prone to one fewer sources of possible estimation bias.

The FAF³ Mode Classes have also changed since 2002. Table A1 below shows the differences. Note that, due to the redefinition and changed reporting of intermodal/multimodal categories between the 2002 and 2007 CFS on which the FAF is based, there is no direct equivalence in the modal classes implied between these two sets of definitions,. Differences in the way the 2007 versus the 2002 CFS assigned water-only versus water-inclusive intermodal shipments (typically, truck-water combinations) also means that direct comparisons of water only traffic volumes and modal shares is problematic.

Table A1. Modal Class Changes 2002 – 2007

FAF2 Modes (2002)	FAF3 Modes (2007)
Truck	Truck
Rail	Rail
Water	Water
Air, air and truck	Air,air and truck
Truck and rail	Multiple modes and Mail
Other intermodal ¹	Pipeline
Pipeline and Unknown	Other and Unknown

FAF² “Other intermodal” includes U.S. Postal Service and courier shipments and all intermodal combinations except air and truck.

FAF³ Modal definitions are given below:

Table A2. FAF³ Modal Definitions

Mode Identification	Mode Name	Mode Description
1	Truck	Includes private and for-hire truck. Private trucks are owned or operated by shippers, and exclude personal use vehicles hauling over-the-counter purchases from retail establishments.
2	Rail	Any common carrier or private railroad.
3	Water	Includes shallow draft, deep draft and Great Lakes shipments.
4	Air (includes truck-air)	Includes shipments typically weighing more than 100 pounds that move by air or a combination of truck and air in commercial or private aircraft. Includes air freight and air express. Shipments typically weighing 100 pounds or less are classified with <i>Multiple Modes and Mail</i>
5	Multiple Modes and Mail	Includes shipments by multiple modes and by parcel delivery services, U.S. Postal Service, or couriers. This category is not limited to containerized or trailer-on-flatcar shipments.
6	Pipeline	Includes flows from offshore wells to land, which are counted as water moves by the U.S. Army Corps of Engineers.
7	Other and Unknown	Includes flyaway aircraft, vessels, and vehicles moving under their own power from the manufacturer to a customer and not carrying any freight, unknown, and miscellaneous other modes of transport.
8	No Domestic Mode	A 'No Domestic Mode' category is used to capture petroleum imports that go directly from foreign, inbound ships to an on-shore US refinery. This is done to ensure a proper accounting when foreign and domestic flows are summed, while avoiding assigning flows to the domestic transportation network that do not use it.

FAF² modal definitions are as follows:

1 – 4. Truck, Rail, Water and Air (including truck-air) definitions are the same as those used in FAF³.

5. Truck-Rail Intermodal—Shipments that use a combination of truck and rail.

6. Other Multiple Modes—Includes Parcel (U.S. Postal Service or Courier), truck-water, and water-rail.

7. Other and Unknown Modes—Includes Pipeline and any mode not listed above.

The FAF³ Commodity Classes, like those in FAF², mirror the 43, 2-digit (i.e. most aggregate) SCTG classes reported by the 2007 CFS. Differences in the composition of these classes between 2002 and 2007 are relatively minor, with two exceptions:

- Printed product flows, which were absent from the 2002 CFS and hence modeled as OOS flows in FAF² were covered in the 2007 CFS.
- A second change for FAF³ was the O-D specific treatment of natural gas products, which were evaluated only at the level of national or broad regional activity totals in FAF².